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Systems of Electric Transmission

Review of Various Systems, with Comment on Present-Day Tendencies Regarding Voltages, Tie Lines, Transmission of Continuous Currents, Underground Cables, Interurban and Rural Lines

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This is the second of a series of articles in which Prof. Still will review the electric power situation. The purpose will be to indicate the general nature of the problems the engineer has had to overcome, and also to show in what way present tendencies may influence practice in the future.

The first article, which was of an introductory character, reviewed present-day conditions and practice in the development of electric power plants and distribution systems. It appeared in our issue of July 17. Subsequent articles will be published in our "Electrical Construction" and "Central-Station and Power-Plant" issues.—Editor's Note.

The earliest system of distribution actually used in the lighting of city streets was the direct-current, high-voltage, series system. The 10-ampere, direct-current arc lamp being the first practical device for producing light by electrical means, the design of continuous-current machines, provided with more or less efficient commutators, and regulators to maintain a constant current, rendered possible the series connection of a large number of lamps on one circuit. The direct-current arc-lamp series system was first used for street lighting in about 1880. The

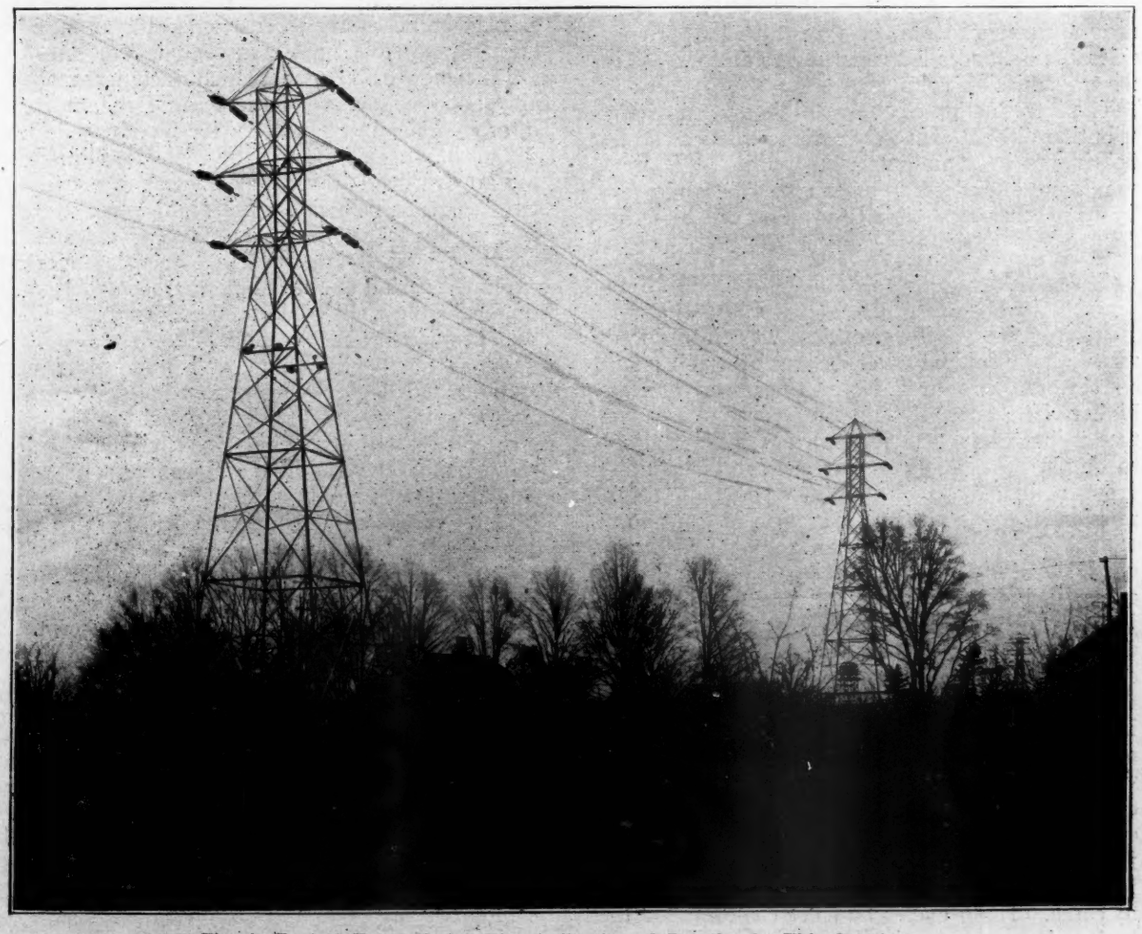


Fig. 1—Typical Transmission Line Indicative of Practice in This Country.

Thury system, as used in Europe for the transmission of large amounts of electrical energy at very high voltages, is merely a later development of these early arc-lighting systems.

The first parallel or multiple system, using 110-volt incandescent lamps on two-wire, direct-current mains was put into operation at Appleton, Wis., in 1882. The mains and feeders on these earlier low-voltage systems were run underground in tubes. The three-wire system, with 220 volts between the outer conductors, as used at the present time, was the result of an effort to reduce the large weight of copper required when transmitting energy over an appreciable distance at as low a pressure as 110 volts. Further attempts to reduce the cost of mains led to the development and adoption of the alternating-current system with static transformers to raise and lower the pressure as required. An alternating-current system was put in operation by the Westinghouse company at Greenburg, Pa., as early as 1886.

A frequency of 125 cycles per second was common in connection with the earlier alternating-current systems in America. With the introduction of the polyphase system in 1888, the alternating-current motor entered the field in competition with the direct-current motor and led to a reduction in the standard frequency because of difficulties in designing satisfactory motors for operation on high-frequency circuits. The two-phase system working at 60 cycles and a maximum pressure of 2200 volts became the recognized standard until the demand for large amounts of energy to be transmitted over considerable distances led naturally to an increase in the transmission voltage.

The introduction of the multiple system of distribution did not cause the series system of street lighting to be abandoned; but, with the flaming arc lamp and, later, the tungsten incandescent lamp, it became possible to use 60-cycle alternating current on the series system.

Frequencies Used for the Transmission of Power.

A frequency of 25 cycles was introduced, mainly because the earlier designs of synchronous converters operated better on the lower than the higher frequencies. The first three-phase system using synchronous converters in substations to obtain 110-volt direct current for distribution from a high-voltage alternating-current transmission line was put into operation in Chicago in 1897. Pressures as high as 20,000 volts were used shortly afterward in some of the larger cities, including Chicago and Boston. The objections to the use of 50-cycle and 60-cycle frequencies on circuits connected to synchronous converters for transforming the alternating current into continuous current were overcome by improvements in the design of dynamoelectric machinery, including the addition of series-wound interpoles which greatly improved the commutation. Unfortunately, 25 cycles has become so firmly established as one of the standard frequencies in America that apparatus for this frequency will probably be built for many years to come. If 50 cycles had been chosen for the higher frequency, as in Europe, where it is very commonly used, the design of motor-generator sets to connect two systems of different frequencies would have been simplified.

The transmission of energy between substations in a thickly populated area, or between small towns and villages served by a central power station, involves many questions which do not arise in connection with a straight long-distance transmission, the object of which is to convey energy from a spot, such as a waterfall, where power is cheap, to the centers of population where there is a demand for it. In the former case, the problems to be solved are generally similar to those of distributing systems in large cities, except that the pressures are much higher on account of the greater distances to be covered. In the latter case—that of straight long-distance transmission, with few, if any, connections between the generating station and the substation from which the energy is distributed at a lower pressure—the chief considerations are those involved in the choice of transmission voltage and

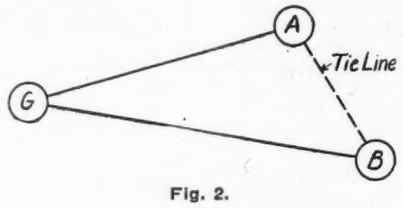


Fig. 2.

a line construction which shall combine economy with such safety factors and protective devices as may be necessary to ensure, so far as may be humanly possible, uninterrupted service.

Efficiency of service, which includes reasonably good voltage regulation and freedom from interruptions, must necessarily be merged into the all-important question of cost. By duplicating an overhead transmission line and providing two separate pole lines, preferably on different and widely separated rights of way, insurance is provided against interruption of service over an extended period of time; but whether or not such duplicate lines shall be erected must be decided on purely economic grounds.

When the system embodies a number of substations and two or more generating stations, the proper arrangement of the transmission lines becomes a matter involving very careful study on the part of the engineer. Energy may be obtained at intermediate stations by tapping a radial line, i.e., a direct line connecting the point of supply with the point of delivery; but tie lies between two substations are also of great value in permitting equalization of load on two or more radial lines. The illustrations show three possible arrangements of lines supplying energy from a single generating station. Fig. 2 shows a tie line between two substations, the purpose of which is to control the loading of the two radial lines and also to maintain supply in the event of a breakdown on one of the direct lines. Figs. 3 and 4 show how a third substation, *C*, of relatively small capacity may be supplied with energy.

Although induction motors will operate as satisfactorily on two-phase as on three-phase systems, the former type is little used now, mainly

because four wires are necessary on two-phase transmissions of any magnitude. The use of a common-return conductor leads to alterations in the phase angle when the line is transmitting a heavy load. If four wires are to be used, a better system is the three-phase with a fourth conductor feeding the neutral point of a star-connected system. The first large four-wire system was established in Chicago in 1898 for the purpose of feeding outlying districts. The lighting load is connected between the neutral wire and any one of the other three wires. The neutral wire will take care of the unbalanced currents when the three phases are not loaded equally.

Transmission of Energy by Means of Continuous Currents.

We are so familiar in this country with the three-phase overhead transmission system that we tend to overlook certain possible alternatives. In Europe underground cables are usually preferred to overhead wires when the distance of transmission is not great, and the Thury system is used in about 16 independent transmission systems utilizing direct-current pressures up to 100,000 volts. The high voltage is obtained by connecting a number of generators in series; the pressure across any one commutator does not exceed 5000 volts.

In the Thury system of electric power transmission by continuous currents, the current is constant in value and the pressure is made to vary with the load. All the generators and all the motors are connected in series on the one wire, which may be in the form of a closed loop serving a wide area; or the system may consist merely of the outgoing and returning wires between a power station containing all the generators, and one or more substations, with motors, at the end of a direct transmission line.

The difficulty of insulating between machines and ground is overcome by mounting the dynamos and motors on insulators and providing an insulated coupling between the electric generators and the prime movers. An insulating floor is also provided.

The motors may be distributed anywhere along the line, either on the premises of private users of power, where they may be directly coupled to the machinery to be driven, or they may be installed in substations, coupled to constant-pressure electric generators giving a secondary supply for lighting and power purposes. In most of the Thury undertakings in Europe, this secondary supply is three-phase alternating current.

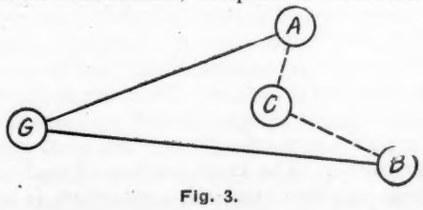


Fig. 3.

Just as various devices are provided, when working on the parallel system, to maintain constant pressure of supply, so in the series system it is necessary to provide regulating devices to maintain a constant current. Regulators controlled by the main current, or by a definite fraction of the main current passing through a solenoid, can be made to act on mechanism designed to vary the speed of the prime movers. This method is quite practicable, but, where the type of prime movers—such as a waterwheel under constant head—is not suited to variable-speed operation, the machines may be run at constant speed, and an automatic device made to alter the magnetic field cut by the armature conductors, this being the only alternative means of varying the voltage generated.

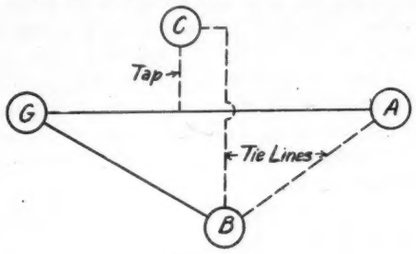


Fig. 4.

A short-circuit on a motor merely removes that portion of the total load from the system, and the regulators on the generators will readjust the pressure accordingly. If a short-circuit occurs on a generator the prime mover may be protected from the shock by a slipping coupling, which is commonly provided. If, owing to the failure of a prime mover, a generator tends to reverse and be driven as a motor, it may be short-circuited by a switch that can very easily be made to operate automatically on reversal of current.

Space does not permit of a detailed discussion of the direct-current series system, but occasions may arise, even in this country, where its peculiar advantages over the alternating-current system may lead to its adoption, provided the engineer will have an open mind and refuse to be governed by custom and prejudice.

Advantages of the Thury System.

The power-factor is unity—a fact which alone accounts for considerable reduction of transmission losses.

Higher pressures can be used than with alternating current, the conditions, as shown by actual tests, being more favorable to direct-current transmission than is generally supposed. Without any alteration to insulation or spacing of wires, approximately double the working pressure can be used if direct current is substituted for alternating current.

The necessity for two wires only, in place of three, effects a saving in the number of insulators required and leads to cheaper line construction.

Where it is necessary to transmit power by underground cables, continuous currents have great advantages over alternating currents. Single-core cables can be made to work with continuous currents at 100,000 volts. By using two such cables and grounding the middle point of the system it is, therefore, quite feasible to transmit underground at 200,000 volts.

There are no induction or capacity troubles and no surges or abnormal pressure rises due to resonance and similar causes, such as have been experienced with alternating currents.

A number of generating stations can easily be

operated in series, and when the demand for power increases, a new generating station can be put up on any part of the line if it is inconvenient to enlarge the original power station.

The simplicity and relatively low cost of the switch gear is remarkable. A switch pillar with ammeter, voltmeter and four-point switch is all the necessary equipment for a generator. The switch pillar for a motor includes, in addition, an automatic "by-pass" which bridges the motor terminals in the event of an excessive pressure rise. This compares very favorably with the ever-increasing—though in some cases unnecessary—complication and high cost of the switching arrangements in high-tension power stations on parallel systems.

For any industrial operation requiring a variable-speed drive at constant torque, the Thury motor, without constant-speed regulator, is admirably adapted. It might have a useful application in the driving of generators supplying constant current to electric furnaces in which the voltage across electrodes is continually varying.

Disadvantages of the Thury System.

The relative smallness of the generators is objectionable, the output of each generator being limited by the line current and the permissible voltage between the collecting brushes on the commutator.

With constant current on the line, the line losses are the same at all loads, and the percentage power loss in conductors is inversely proportional to the load. This is exactly the reverse of what occurs on the alternating-current parallel system, in which the percentage line loss is directly proportional to the load.

The series system is less suitable than the parallel system for distribution of power in the neighborhood of the generating station. It is essentially a transmission system, and not a distributing system.

Special regulating devices are necessary to maintain constant speed on the motors.

It is impossible to overload the motor, even for short periods. This would be a very serious objection to the use of these motors in connection with electric traction systems.

Underground and Submarine Transmission Lines.

The question of underground cables versus overhead conductors does not give rise to as much discussion in America as it does in Europe. Apart from the limitation of voltage, which renders underground cables unsuitable for long-distance transmission, the cost of an underground system of conductors will generally be at least twice that of the equivalent overhead construction. The difference in cost is more noticeable in America, where reasonable factors of safety in overhead construction have been adopted, than in Europe, and especially in England, where legislation has in the past been generally unfavorable to the development of electrical transmission.

When transmission lines or portions of transmission lines have to be laid underground, the thickness and nature of the insulation and the method of laying will affect not only the first cost but also the maintenance charges and the life of the cables. All these factors must be taken into account when deciding upon the most economical type of construction under the varying conditions that are likely to occur in practice. It is usual to draw the insulated conductors into some form of duct or conduit; but conditions may be found under which it would be justifiable to use lead-sheathed and steel-armored cable laid directly in the ground without any additional protection.

The principal use of underground electric cables is in connection with distributing systems in cities, at comparatively low pressures; but they are also used, to a limited extent, for the transmission of energy at fairly high voltages.

Notwithstanding the higher cost of underground transmission, it replaces overhead transmission—for comparatively short distances—in many cases where the latter system is not suitable. High-tension underground cables are used in populous districts where overhead construction is not permissible or advisable. The underground cable is not subject to damage by wind, ice or thunderstorms, and the danger to life is obvously reduced by placing the high-voltage conductors underground. The unsightly appearance of poles and overhead conductors in the neighborhood of cities is another reason for putting wires underground, notwithstanding the increase of cost.

When transmitting electric energy across water which cannot be spanned by overhead conductors, the insulated cable becomes a necessity. Two examples of submarine power transmission occur in San Francisco, where a three-phase, 12,000-volt cable 18,000 ft. long has been laid across the bay, and two 11,000-volt cables have been laid across the Golden Gate.

Important Submarine Transmission Line Abroad.

In Germany there is the Stralsund channel project, transmitting three-phase power at 15,000 volts from the generating station at Stralsund to the island of Rugen, the total length of submarine cable being 5600 ft. Another example occurs in the straits between the mainland and the island of Fehmern, where two 3300-ft. lengths of lead-covered, iron-wire, armored, paper-insulated, 11,000-volt cables are laid under water.

The most important existing submarine power transmission line is the international cable between Sweden and Denmark, which was put into operation in December, 1915. It is 3.4 mi. long and connects a point near Palsjo in Sweden with Marienlyst in Denmark. The cable is three-core with impregnated paper insulation suitable for a working pressure of 35,000 volts (test pressure 87,500 volts). The cross-section of each core is 0.108 sq. in., and steel wire armoring is applied over the lead sheath. The greatest depth of the Oresund at the point traversed by the cable does not exceed 125 ft. The cable was laid in nine lengths of about 2000 ft. each.

When long lines of cable are laid under water, rubber-insulated conductors are preferable to paper or cambric insulation, which would suffer injury from moisture in the event of the protective covering being damaged. The Standard Underground Cable Co. recommends that where the submarine cable is at all likely to be subjected

to considerable tensile strains, the conductors be insulated with an adequate thickness of high-grade rubber compound, served with a rubber-faced tape, covered with a lead sheath protected by a heavy serving of tarred jute, and armored with galvanized steel wires of a size varying with the size of the cable and the conditions under which the cable is to be laid and operated.

Transmission and distribution by underground cables with alternating currents at 20,000 and 22,000 volts is not at all uncommon; but there are not many instances of higher voltage cable systems at the present day. Various schemes are in progress or in contemplation in England for linking up separate systems or parts of systems at pressures from 30,000 to 60,000 volts. A few years ago an extensive system of 30,000-volt, three-phase cables was laid in Berlin, following the experience gained in England with 20,000 volts. There are a few short lengths of 40,000-volt, three-core, three-phase cables in France, and this is probably the highest working voltage applied to three-core cables at the present time. The difficulties—apart from high cost—in the way of increasing the pressure limit, include heavy capacity currents and large dielectric losses, the latter being "all day" losses, like the iron losses of distributing transformers.

It seems nevertheless probable that the future will see important developments in high-voltage cable transmission, notably in connection with electric railways in Switzerland and elsewhere on the continent of Europe, where power cables may be used for pressures up to 80,000 and even 100,000 volts, and of sufficient size to transmit from 10,000 to 20,000 kv-a. per cable.

Discussion of Methods of Laying Underground Cables.

For the transmission of three-phase alternating currents, three-core cables may be used for pressures up to about 60,000 volts. When the pressure exceeds this figure, a separate single-core cable should be used for each phase. These separate cables of an extra-high-tension, three-phase transmission line should be symmetrically arranged with a small amount of insulation between the lead sheath and ground. Steel armored, single-core cables are inadmissible for alternating currents because of the inductive effects.

Power cables may be laid direct in the ground, being protected with only a lead sheath and steel-tape armoring. A cushion of tarred jute is placed over the lead sheath and over this is wound a layer of steel tape, about 1/32 in. thick, in an open spiral, leaving approximately 3/16 in. clearance between the convolutions. A second layer of steel tape is wound over the first so as to cover the unprotected spaces. Finally a heavy covering of tarred jute is wound over the armoring.

The drawing-in system is, however, the one most commonly adopted at the present time. The ducts for the cables may be tile or fiber set in concrete, or they may consist of wrought-iron pipes.

Fiber conduits are light in weight and easy to handle. They are cylindrical pipes made of wood pulp saturated with an asphalt or bituminous compound containing a small amount of creosote, and are usually supplied in 5-ft. lengths.

Iron pipes are useful when slight bends to clear obstructions are of frequent occurrence. These can be supplied in 20-ft. lengths with threaded ends and couplings.

Manholes must be provided at intervals of 300 to 500 ft., the latter distance being rarely exceeded, as it represents the practical length of cable of large size which can be drawn into an underground duct without injury.

The connection between overhead wires and underground cables must be made with great care to avoid trouble at this point. The ends to be attained and the precautions to be taken are fairly obvious, and the engineering difficulties may readily be overcome. Each particular case should be considered as a special problem, and the proper steps taken to provide adequate insulation and prevent deterioration or damage by water owing to improperly sealed joints.

Factors Entering Into Design of Underground Cables.

No attempt will be made here to discuss the various problems entering into the design of underground cables; but since the main business of the cable maker is to provide insulation which shall withstand the ever-increasing voltages for which cables are being used, he must be able to predetermine the potential gradient at the point where this will be a maximum, namely, at the surface of the conductor. He must so design the cable that this will not exceed a certain safe value depending upon the nature of the insulation. By grading cables, i.e., so constructing them that the potential gradient is approximately constant throughout the thickness of the insulation, the diameter and the cost may be reduced. It is probable that further work will be done along these lines as cables are called for to work on higher voltages than in the past.

A large number of three-conductor cables drawn into ducts are used in the larger cities. It is uneconomical to draw small-capacity cables into a costly system of underground ducts; it is best, if possible, to use the largest size of cable that can readily be drawn into a standard duct. Cables to carry about 220 amperes are actually in use on 20,000-volt systems. When the pressure is as low as 6600 volts, the current in each conductor of a three-core cable may be as large as 300 amperes.

It is very important to guard against the possibilities of overheating when power conductors are laid underground. The layers of insulating material close to the conductors will be hotter than those near the surface of the cable; but the difference in temperature between the conductor and the external surface is not easily predetermined. It will depend upon the nature and thickness of the insulation, and also upon the type of cable, i.e., whether two- or three-core, or concentric.

The best conditions for cooling will usually occur with submarine cables; but armored cables buried direct in certain kinds of soil are also capable of dissipating large amounts of energy.

It is possible to run the current densities in three-core, 20,000-volt power cables up to 1000

amperes per sq. in. in cables of 0.25 sq. in. of core section, and even 1500 amperes per sq. in. if the core is not more than 0.1 sq. in. in cross-section. It is rarely safe to allow the lead sheath to reach a temperature greater than 40 deg. C.; but no hard and fast rule can be laid down in this connection.

General or local overheating of cables is perhaps the chief cause of service interruptions on underground systems, yet a liberal cross-section of conductor can hardly be considered as the proper solution of the problem. Attention to all the causes that may lead to local overheating is very important; but the matter is not one that lends itself to lengthy discussion in this article.

Since submarine power cables will transmit much greater amounts of energy for a given size than underground cables, the possibility of flooding the ducts with water, as suggested by Mr. Harper,* deserves consideration.

Interurban Transmission Systems—Rural Lines.

The voltage at which interurban lines should be operated will depend upon the area to be served and the distances over which the energy is to be transmitted. On very extensive systems generating stations serve a large district with lines operating at pressures usually above 60,000 volts. Lower-voltage lines are then run from distributing centers to serve large industrial users and small towns within easy reach of the distributing lines, which usually operate at something between 13,200 and 33,000 volts. Sometimes, where the power stations are not very far from the centers where the demand occurs, the main transmission lines may be operated at about 33,000 volts, and in such cases the transmission lines and the lines of the main system may be tapped to serve large users situated within a short distance of the lines.

Rural districts, within 10 or 12 miles of electric lines, requiring small amounts of power from transformers ranging in size from 5 to 30 kw., may be served with a four-wire, three-phase system operating at 4400 or 6600 volts, but higher pressures are generally more economical. Loads of 500 to 1000 kw. may be served very satisfactorily in this manner. Efforts are now being made to interest the farmer in the many applications of electricity on the modern farm. If the demand is for lighting only it will not be easy to give service at a reasonably low cost; but once the advantages of electric power for the smaller machinery—requiring motors up to 3 hp. and even 5 hp.—have been realized, there should be a good field for electrical energy in many farming districts not too far removed from existing power lines. The equipments for such service, involving simple and reliable switching and protective devices suitable for mounting out of doors on poles, should be very carefully designed. Manufacturers are already devoting their attention to the special problems involved in producing the best possible line of equipment for these low-voltage rural distributing systems, and good results are to be expected if those responsible for these undertakings will insist upon good materials and sound construction as the surest means of attaining ultimate economy.

By paying proper attention to the needs of the consumer and devoting as much study to the problems of the small distributing lines as to the larger power schemes, the central-station industry as a whole will be greatly benefited, but so far as can be judged at the present time the immediate result in this country will be to build ever larger power stations—both steam operated and hydroelectric—and transmit electrical energy over large interconnected areas by three-phase currents at pressures of 220,000 volts or higher.

The recent growth of high-voltage power transmission on the North American continent has been almost phenomenal, both in the capacity of the power stations and the voltage. Twenty years ago plants operating at anything above 44,000 volts were almost unknown, yet today there are about 75 plants in the United States, Canada and Mexico operating at pressures above 44,000 volts, and the majority of these have from 66,000 to 150,000 volts on their transmission lines.

*"Problems of Operation and Maintenance of Underground Cables," by J. L. Harper. Trans. A. I. E. E., p. 417, Vol. XXXVI, 1917.

NEW CONSTRUCTION AND SERVICES IN PITTSBURGH.

Growth of the central-station system and business in Pittsburgh is well illustrated by a series of comments made in a recent issue of the Duquesne Light Co. *News*. These statements show that a total of 14,000 new meters were installed, and that the total number of active service contracts were increased by 13,796 during the past year. The total lighting load was increased during this period by 5915 kw. There were 1700 series tungsten lamps installed to replace municipal arc lamps and to increase the size of the street lighting system. About 35 mi. of new 11,000, 22,000 and 66,000-volt overhead line construction, and 37.5 mi. of 2200-volt overhead lighting circuits were added to the system.

A total of 77 mi. of line was erected for arc lights, 11 mi. was erected for low-tension distribution, and 5 mi. of underground cable was installed. Additional underground construction required the building of 59,258 duct feet of conduit, and the overhead construction involved the setting of 3474 poles.

WILL USE ELECTRICITY AS AID IN HARBOR NAVIGATION.

The United States Light House Department will lay a 16-mi. cable from Fort Lafayette to the Ambrose Channel in lower New York bay, through which on foggy days a 500-cycle, a-c. electrical current will be sent to be used to guide vessels into New York harbor through the thickest fog. Wire coils hung over the sides of inbound ships will enable the wireless operator to catch radio emanations and determine the exact position of the ship in the channel at all times. If the plan proves successful additional cables may be used in the East river, through Hell Gate, to Long Island sound. It may be adapted also in some of the narrow channels of the Great Lakes.

Construction of a Modern Power Generating Plant

Details of Boiler and Turbine-Room Equipment, Generating, Distributing and Control Systems of West End Station, Union Gas & Electric Co.—Paper Before Ohio Electric Light Association

By F. D. WYATT

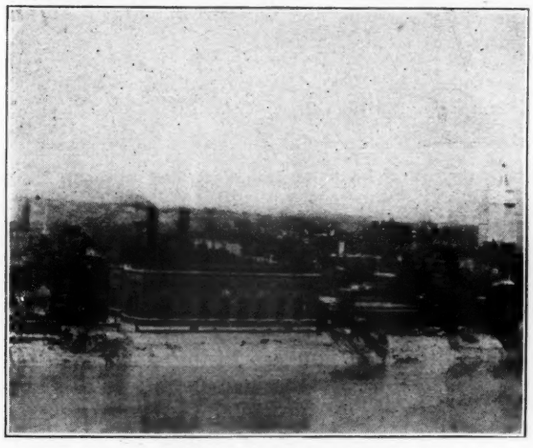
The need of a new power station in Cincinnati, O., to replace the old Plum Street station became evident to the management of the Union Gas & Electric Co. nearly ten years ago, but very little action was taken until 1914 and 1915, when the rapidly increasing load and the decision of the city authorities to dry the canal, which provided the old station's only water supply, combined to bring matters to a head. It was finally decided to erect a new station beside the Ohio river on the site of the old West End gas works, which had been unused since the completion of a natural-gas pipe line from the West Virginia fields. Ground was broken on June 1, 1916, and the work went ahead rapidly for nearly a year, until our entry into the world war. During the first few months of the war there were innumerable delays to the work, but as the demand for power for war industries increased the construction of the building and equipment was rushed more and more, and on July 30, 1918, the first unit was placed in operation, followed in a short time by the second unit.

Contrary to the expectations of many, the end of the war did not cause any diminution in the demand for power; on the contrary, the percentage of increase in load has been greater in the last year than ever before, and contracts were let for a third and later a fourth generating unit. Installation of the third unit is now progressing rapidly, and it is believed that the fourth unit will be ready for operation within the next year.

Coal Handling and Storage.

The main coal-storage yard, having a capacity of 50,000 tons, is on the north side of the building and has direct track connections with the Baltimore & Ohio and Chesapeake & Ohio railroads. Coal is dumped from the railway cars into concrete lined pits, and moved to the storage piles by a Whiting gantry crane which has a span of 139 ft. and a capacity with a 5 cu. yd. bucket of 250 tons per hr. A crusher has been installed in the leg of the gantry, and all coal is crushed before being taken into the plant. There are additional storage spaces east of the plant with a capacity of 30,000 tons, giving a total storage capacity of 80,000 tons. There are no conveyors in use, coal being taken into the plant in eight air-operated side-dump standard gauge cars having a capacity of 33 cu. yds. each. The switching locomotive used is somewhat unusual, being of the steam storage type. There are only ten other such equipments in operation in this country, all being smaller than this one. The drum is charged with steam from the main boiler-room header twice a day. Its efficiency compares favorably with that of a coal-fired engine.

There are eight concrete-lined coal pits, with a total capacity of 7000 tons, directly under the



South View of West End Station.

boiler room, from which coal is hoisted through openings in the boiler-room floor to the bunkers over the boilers. The building itself is a steel, concrete and brick structure, approximately 300 ft. long, 220 ft. wide, and 100 ft. high, with an extension 30 by 70 by 100 ft., containing operating room, battery room, and offices, at the southwest corner. The turbine room is 65 ft. wide and extends the full length of the building on the south, or river side, the boiler plant occupying the remainder of the building.

One of the most interesting features of the building is the substructure construction. There is a variation of approximately 70 ft. in the level of the Ohio river at Cincinnati between extreme-high and extreme-low water, which made the conventional arrangement of condensing equipment impracticable. A system of wells was adopted, the turbine-room floor being above high water with the condensers and their auxiliaries placed in wells below river level at low water. There are five pits—an intake well, connected by a tunnel with the bottom of the river, in the center, with a condenser well on either side of it. Between the intake well and the condenser wells are smaller discharge wells also connected with the river through tunnels. The construction and use of these wells will be described in more detail in connection with the condensing equipment.

In the boiler plant the coal pits and coal-hand-

ling apparatus are in the center, with a row of boilers on either side. Economizers are installed directly over the boilers, four being connected by a breeching to each stack. Forced-draft fans are located on the boiler-room floor behind the boilers, and induced-draft fans in the economizer outlets. Feed-water heaters are set on a gallery and the boiler feed pumps are installed on the main floor between the south row of boilers and

Operating Room of the West End Station.

the turbine room. In the turbine plant there are two units over the condenser well, with the condensers on the pit floor, and in the switchhouse above the turbine room are installed all high-tension buses, oil circuit-breakers, and reactors.

Individual coal bunkers of 100 tons capacity, sufficient for 20 hrs. normal operation, are provided for each boiler. Coal is hoisted from the boiler-plant coal pits to these bunkers by means of two 10-ton Whiting cranes, equipped with 3-yd. clam-shell buckets, with a capacity of 100 tons per hr. each. Both cranes are arranged to weigh each bucket full of coal. There are two feed-water heaters, with two boiler-feed pumps for each heater, one pump being able to handle all the water from one heater leaving one pump in reserve for each heater. All are Worthington centrifugal pumps with a capacity of 850 g.p.m. against a 750-ft. head, and feed water to the economizers at a pressure of 300 lbs. per sq. in.

Boiler and Stoker Equipment.

Each of the eight Babcock & Wilcox boilers now installed is equipped with a 14-retort Westinghouse underfeed stoker in one end of the furnace and gas burners in the opposite end. This type of stoker is divided into four sections of three and four retorts each, any one of which may be disengaged from the driving mechanism by a clutch. In addition to the clutch each section is provided with a shearing pin to automatically disengage the driving mechanism should any foreign matter block the action of the main ram. Each stoker is driven by a 35-hp., variable-speed d-c. motor. In case of breakdown of one of the motors, the shafts of two or even more adjoining stokers may be connected, thus enabling them to be driven by one motor. As each stoker requires but 5 hp. under heaviest operating conditions, one motor can drive two or more stokers without difficulty. The fuel bed in the Westinghouse stoker is heavy over the rams and tapers down to a thin bed over the dump grates, where the last combustible in the coal is burned. Air is admitted to the fire through tuyeres and over the fire through air-distribution boxes, and is also admitted to the rear dump grates. There is no other stoker with this particular feature, which has a double function of keeping the combustible in the ash low and of keeping the dump grates cool.

The Gwynne gas burners, which are now being installed in the station, ten to the boiler, are made up of a nest of fifty 0.375-in. tubes connected to a common header. When gas is being burned the stoker is covered with layers of gray ash, sheet iron, and fire brick; and when coal is used the bridge wall is built up in front of the gas burners. The ash hoppers are beneath the boilers and discharge directly into standard railroad cars; this has proved to be a very economical method of ash disposal.

A Sturtevant economizer is installed over each boiler. Gases enter at the front end and pass out through an induced-draft fan at the rear into the breeching and then to the stack. The induced-draft fans create a draft of 1.25 in. of water at the economizer inlet. Each economizer is equipped with automatic continuously operating scrapers to keep the tubes free from soot. The soot collects in a hopper below, from which it is removed by a steam-jet soot conveyor. A complete set of indicating and recording instruments is installed on each boiler so that, insofar as operating records are concerned, the boiler is virtually running under test conditions daily.

Intake Wells and Tunnels.

The intake tunnel through which water is brought into the plant from the river is made of concrete and is 10 ft. wide and 25 ft. high, the mouth of the tunnel being just below the low-water line and at right angles to the flow of the river. The water flows from the tunnel into the intake well, which is 60 ft. in diameter, 86 ft deep from the basement floor and has 6-ft. concrete walls. The bottom of the well is 15 ft. lower than the lowest recorded water level in the river. In this well are a set of gratings composed of 3-in. by 0.25-in. vertical bars placed on 2.25-in. centers, traveling screens with 0.5-in. mesh and sliding screens with 0.5-in. mesh These screens effectively remove from the water all debris large enough to injure either the condensers or pumps. Condenser wells are 68 ft. in diameter and 70 ft. deep from the basement floor. They have 8-ft. concrete walls, and the bottoms are made in the shape of inverted domes 24 ft. through at the thickest point. Condensing water is brought in from the intake through 54-in. pipes in the well floor to the circulating pumps and goes from the condensers through 54-in. pipes to the discharge well and back to the river. The entire circulating system is in the form of a siphon, being sealed from the intake to the discharge, both being below river level, so that the only duty of the circulating pumps is to overcome friction.

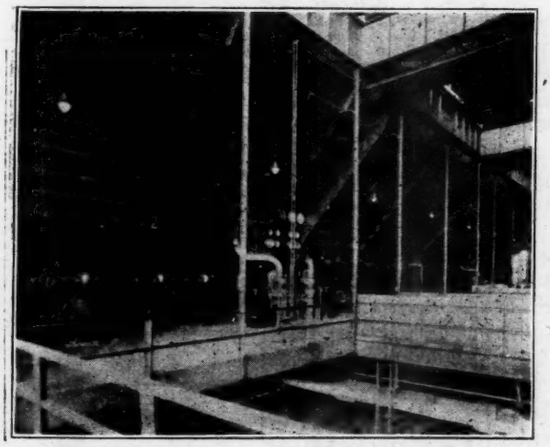
Water is supplied to each condenser by a motor-operated, Worthington, 42-in. centrifugal

pump having a capacity of 56,000 g.p.m. against a 25-ft. head. The amount of water supplied to the condenser can be regulated by means of hydraulically operated valves in both intake and discharge lines. Worthington two-pass vertical surface condensers, each containing nearly 12,000 tubes and having a cooling surface of 52,000 sq. ft., are used. With circulating water at 40 deg. F., and the generator carrying full load, a vacuum of from 0.6 to 0.7 ins. absolute is regularly obtained.

To exhaust air and vapor, each condenser is equipped with four Worthington hydraulic vacuum pumps. Water is supplied to these pumps by two Worthington centrifugal pumps and is returned, through cooling coils, to maintain a constant low temperature, to a tank conveniently located so that it may be used over and over. Exhaust steam from the turbines passes through pipes 13 ft. in diameter and 65 ft. long to the condensers. The hotwells for condensate collection are located in the bases of these exhaust pipes, and the condensate is returned to the feedwater heaters through a preheater in which the condensate absorbs heat from the exhaust steam. Worthington motor-driven two-stage pumps, two to each condenser, with a capacity of 1200 g.p.m. against a 205-ft. head are used to force the water through this system. Service water for miscellaneous uses is supplied by three service pumps located in the condenser pit.

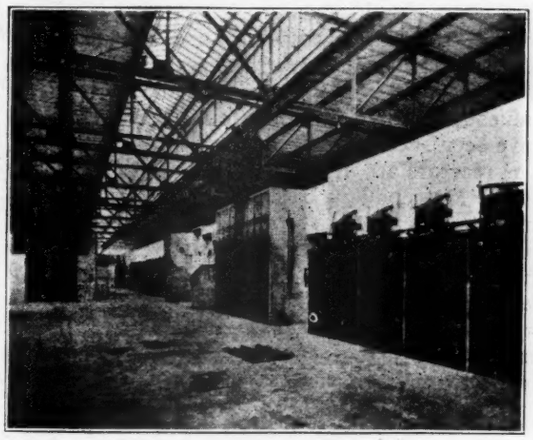
Details of Electrical Equipment.

The two generating units now in use are located over the west condenser well, and the third and fourth units are being installed over the east well. These two turbines are exactly similar, and are of the General Electric Curtis single-cylinder, 17-stage, impulse type. Each is rated at 25,000-kw. at 80% power-factor, and they are designed for 230 lbs. per sq. in. steam pressure and 200 deg. superheat. There are two steam admission valves, the first opening into the first stage and being controlled by the governor until a load of 22,000 kw. is reached. At loads above this



North Firing Aisle in the Boiler Plant.

value the secondary valve, which opens into the sixth stage, operates, allowing the steam necessary to carry the additional load to by-pass the first five stages. For this reason the economy of the turbine is highest at a load of approximately 22,000 kw. Each turbine has an oil tank of 1100 gal. capacity and a Schutte & Koerting oil cooler. An impression of the size of these turbines can be gained from the facts that the 17th, or last, stage, is 10 ft. 6 in. in diameter and at 1800



Switch House Showing Structure and Switch Compartments.

r.p.m. has a peripheral velocity of 1000 ft. per sec. or 11.5 mi. per min.

Direct connected to each turbine is a General Electric alternator rated at 31,250 kv-a., 80% power-factor, 13,200 volts, 3-phase, 60 cycles. Excitation is normally provided by an exciter mounted on the end of the generator shaft, but may be supplied from either a steam-driven exciter or a storage battery in case of emergency. At 25,000-kw. load with 80% lagging power-factor, 100 kw. is required for excitation. Cooling air in the amount of 70,000 cu. ft. per min. for each generator is cleaned in spray washers, and after passing through the generator is discharged into the boiler-room basement and used as a supply to the forced-draft fans.

All motors on equipment which requires a wide speed range are operated on direct-current supplied from two Westinghouse 750-kw., 600-volt rotary converters. The remainder of the electrically operated auxiliaries are supplied from three-phase, water-cooled, 1800-kv-a,. 600-volt transformers, one for each unit. There are two storage batteries provided for emergency use—one of 55 cells, 125 volts and 160 ampere-hour capacity, which is kept floating on the 125-volt d-c. control bus. This bus is normally supplied by a 25-kw. motor-generator set and is used for energizing switchboard control circuits. The other is a 126-cell, 250-volt, 800-ampere-hour battery which supplies the main unit excitation bus in case of exciter trouble, and also supplies current for emergency station lighting.

The operating room is located above and west of the turbine room and contains two main control boards and the battery controls. All station equipment is controlled from a benchboard so located that the operator has a clear view of the turbine room, and all controls for outgoing feeders are located on a vertical board on the opposite side of the room from the benchboard. Indicating and recording meters on station equipment and outgoing feeders are located in this room. A double-ring bus system, consisting of main and

reserve buses, is used, and the buses are divided into sections, each supplied by one generating unit, and separated by bus reactances. A set of reactors is also installed on each tap off the bus.

With large generating units, such as the ones in use at the West End station, there is danger of a short-circuit causing excessively heavy currents to flow and set up high stresses in the bus structures and oil circuit breakers. The reactors were installed to limit short-circuit currents to values that would not damage the equipment, and have been successful in accomplishing this object. Bus reactors are of the porcelain-clad type, made by the Metropolitan Electrical Products Co., and are rated at 5%, 1400 amperes and 13,200 volts. Feeder reactors of the same type were made by the same company and are rated at 3%, 300 amperes and 13,200 volts. The reserve bus structure is immediately behind the main bus, both structures being of concrete with transite doors over all compartments.

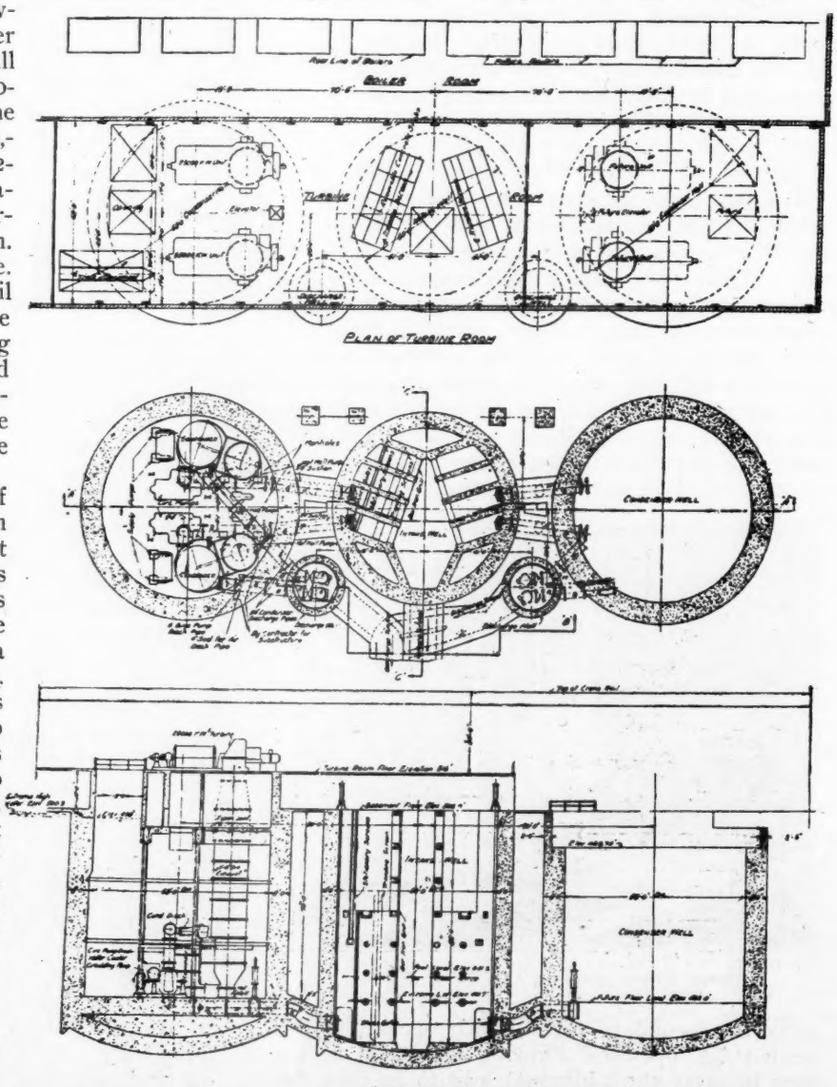
Distribution System.

At present there are 18 cables leaving the station, feeding seven substations and connecting with the Union Light, Heat & Power Co.'s system in Covington and Newport, Ky., across the river from Cincinnati. They are all three-phase, three-wire, 60-cycle, 13,200-volt lines, the cables themselves being 400,000cir. mil in size, with 7/32-in. and 7/32-in. paper insulation and 0/64-in. lead covering, and are carried in 4-5-in. fiber ducts laid in concrete. There are two types of oil circuit-breakers in use, the Westinghouse type O-2 being used between generators and buses and between bus sections, and the Westinghouse type E-6 on all taps of the bus.

The downtown district of Cincinnati is supplied with 120-240-volt direct-current from three converter stations located at convenient points in the d-c. territory. The standard converter used is a 3500-kw., booster-type rotary. three Westinghouse machines being in use now with two General Electric machines contracted for. There are two storage batteries on the d-c. system to assure a constant current supply during emergencies. The larger of the two is a 105-plate H-Exide battery having a maximum capacity of 35,000 amperes, or 10,500 kw. for 6 min. A new battery is now being installed which will have a somewhat greater capacity. When the installation is complete, the three batteries will be able to carry the maximum three-wire d-c. load for 9 min.

The rest of the city is supplied with 60-cycle alternating-current distributed at 4500 volts, three-phase, four-wire from five a-c. substations and one reserve steam station. This supply is stepped down to 120 volts for lighting and to other convenient voltages for power. Constant voltage is maintained on all 4500-volt feeders by means of voltage regulators. Distribution from the West End station to all substations is at 13,200 volts. With the exception of a portion of the downtown district, which is provided with boulevard lighting, the city streets are lighted with 4-ampere, d-c. series magnetite arc lamps, supplied from mercury-tube rectifier transformers located at the various substations. A system of operating and maintenance records has been devised which, while still in the process of development and far from perfection, is giving satisfactory results.

The almost phenomenal growth of the system load has been experienced in the last few years. The load for the first six months of 1920 shows a 40% increase over the corresponding months supplied from mercury-tube rectifier transformers



Plan of Turbine Room and Details of Intake and Condenser Wells.

Stresses in Suspended Wires and Cables—Part II.*

Solution by Means of Laws and Equations of the Catenary of the Fundamental Problems of Transmission Line Stresses, Including the Effect of Temperature, Wind and Sleet on Suspended Wires

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As the financial efficiency of long distance lines for the transmission of electrical power depends upon the proper span distance to meet with the requisite mechanical specifications, which vary widely with climatic conditions, it will be advisable to carefully consider some of the fundamental mechanical features entering into transmission efficiency. One important consideration is the cost of the suspended wire or cable. This cost depends upon its actual length, which is a function of the sag, and upon its size. Usually the mechanical requirement as to the proper tension determines the size.

The general equation of a catenary is

$$y = \frac{m}{2}(e^{x/m} + e^{-x/m}),$$

in which y denotes the ordinate of any chosen point on the curve, x the abscissa of the same point and m the so-called parameter, which may be either a constant or a variable. The expression for the tension at the support, as derived in Part I, appearing on page 5 of ELECTRICAL REVIEW of July 3, 1920, is

$$T_1 = \omega\frac{m}{2}(e^{a/2m} + e^{-a/2m})$$

where a denotes the horizontal distance in feet between the points of support and ω denotes the weight of the wire in lbs. per ft. It will be useful to have some knowledge regarding the numerical value of T_1 in a cable suspended between two points in the same horizontal line, for various sags, if the distance between supports remains constant. In other words, while a remains constant in the last equation, the numerical values of T_1 will be computed for various assumed values for m; assuming the weight of cable to be $\omega = 1.2$ lbs. per ft.

Since $y_1 = m + s$, any assumed value for m will essentially amount to fixing a value for the sag s. The value of the span distance will be assumed to be $a = 4427$ ft. Then $a/2 = 2213.5$ ft. First let it be assumed that m is 1846 ft.

$$\text{Then } T_1 = \frac{1.2 \times 1846}{2}\left(e^{2213/1846} + \frac{1}{e^{2213/1846}}\right)$$

$$= 1.2 \times 923\left(e^{1.19} + \frac{1}{e^{1.19}}\right) \text{ very nearly.}$$

$$= 1.2 \times 3338.84 = 4006.6 \text{ lbs.}$$

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For this case the sag is $y_1 - m = 3338 - 1846 = 1492$ ft. This is the minimum-tension sag (4427×0.337) and 4006.6 lbs. is the minimum tension possible for this cable.

If the diameter of the assumed cable is 0.875 in., its area is $0.7854 \times (0.875)^2 = 0.601$ sq. in., and the tension per sq. in. will be $4006.6/0.601 = 6664$ lbs.

Now let it be assumed that m is 17,500 ft.

$$\text{Then } T_1 = 1.2 \times 8750\left(e^{2213/17,500} + \frac{1}{e^{2213/17,500}}\right)$$

$$= 21{,}167 \text{ lbs., very nearly.}$$

In this case the sag $s = 17{,}639 - 17{,}500 = 139$ ft. Several values of m with the corresponding values of sag, length, tension, etc., are given in the accompanying tabulation.

It is evident from the foregoing that the tension may be computed and the sag predetermined for any given installation, so that the tension may be made not to exceed a predetermined value. In practice this value should be some fraction, about 0.25 or 0.2, of the elastic-limit of the material employed. This leads to the very important matter of the increase in the tension T_1 due to the decrease in temperature, which will be considered in the next section.

TABLE SHOWING VALUES OF VARIOUS FACTORS IN FEET OR POUNDS.

m	y_1	s	L_1	T_1
1,000		3,613.00		5,566.40
1,846		1,492.00		4,006.60
12,000	12,205.54	205.92	4,452.36	14,646.60
13,000	13,188.89	188.89	4,448.34	15,826.66
14,000	14,175.28	175.28	4,445.56	17,010.33
16,000	16,153.36	153.36	4,441.28	19,384.03
17,000	17,144.24	144.24	4,439.55	20,573.08
20,000	20,122.00	122.00	4,326.00	24,146.40
22,135	22,245.67	110.67	4,434.52	26,694.80

VARIATION IN TENSION DUE TO CHANGES IN TEMPERATURE.

If a cable is installed when the temperature is at 70 deg. F., and later the temperature becomes less, the cable shortens or contracts; contraction with reduced temperature being a characteristic property of all material employed in engineering construction. The amount which the cable shortens due to a decrease in temperature of one degree depends upon the kind of material of which the suspended cable is made, or in common terms upon its temperature coefficient. By temperature coefficient is meant the amount a given material 1 ft. in length will shorten due to a decrease in

temperature of 1 deg. The numerical value of the temperature coefficient for each material depends upon the thermometer scale employed.

A number of temperature coefficients, applying to various materials employed for cables, is given in the accompanying table. It is obviously essential to know the extreme temperature range that is likely to occur in the locality in which long suspensions are to be installed when computing the various tensions that may exist.

MEAN COEFFICIENT OF LINEAL EXPANSION.

	Fahrenheit.	Centigrade.
Steel	.0000064	.0000118
Hard-drawn copper	.0000094	.0000171
Aluminum	.0000128	.0000231

If a cable is to be installed in northern New England in the summer, when the temperature may be 130 deg. F., it is necessary to know how much sag to allow in order that a winter temperature of —40 deg. F. shall not sufficiently reduce the length and sag to stress the cable beyond the elastic limit.

Suppose a cable is installed at a temperature of 130 deg. F., with a sag of 188.89 ft., between two points on the same level 4427 ft. apart and

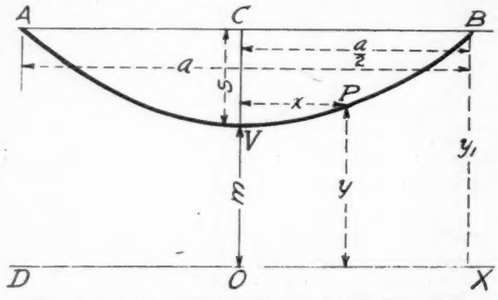


Fig. 1.—Various Dimensions of the Catenary.

it is desired to find the tension at the point of support when the temperature falls to —41 deg. F. The actual length of the cable, when the sag and span distance are as given, may be expressed by the equation

$$L = m\left(e^{2213.5/m} - \frac{1}{e^{2213.5/m}}\right)$$

$$= 13{,}000\left(e^{2213.5/13{,}000} - \frac{1}{e^{2213.5/13{,}000}}\right)$$

$$= 13{,}000\left(e^{0.17026} - \frac{1}{e^{0.17026}}\right)$$

$$= 13{,}000\,(1.18562 - 0.84344)$$

$$= 13{,}000 \times 0.34218$$

$$= 4448.34 \text{ ft.}$$

This is (4448.34 — 4427 =) 21.34 ft. longer than the span distance, and the tension at the support corresponding with this length is, from the table, 15,826.6 lbs. and amounts to a tension of

$$\left(\frac{15{,}826.6}{0.601} =\right) \text{ 26,333 lbs. per sq. in.}$$

If the temperature falls from 130 deg. F. to —41 deg. F. the temperature range is (130 + 41 =) 171 deg. Since the temperature coefficient for steel is .0000064, the length of the cable at —41 deg. F. will become

$$L_1 = 4448.34\,(1 - .0000064 \times 171)$$

$$= 4448.34 - 4.89$$

$$= 4443.45 \text{ ft.}$$

The new length L_1 means a new value for m, y_1 and for the tension T_1 at the support.

If the new value of m can be found, the corresponding value of y_1 may be found and also the new sag corresponding with the temperature of —41 deg. F. The new value of m may be found by solution of the fundamental equation of length as follows:

$$4443.45 = m\left(e^{2213.5/m} - \frac{1}{e^{2213.5/m}}\right)$$

$$\frac{4443.45}{m}e^{2213.5/m} = e^{(2\times 2213.5)/m} - 1$$

$$e^{(2\times 2213.5)/m} - \frac{4443.45}{m}e^{2213.5/m} = 1$$

By addition of the square of one half the coefficient of $e^{2213.5/m}$ to both sides of this equation it becomes

$$e^{(2\times 2213.5)/m} - \frac{4443.45}{m}e^{2213.5/m} + \left(\frac{4443.45}{2m}\right)^2 = 1 + \left(\frac{4443.45}{2m}\right)^2$$

The roots of this equation are determined after extracting the square root of both members.

$$e^{2213.5/m} - \frac{4443.45}{2m} = \pm\sqrt{\frac{4m^2 + (4443.45)^2}{4m^2}}$$

$$e^{2213.5/m} = \frac{4443.45}{2m} \pm \frac{1}{2m}\sqrt{4m^2 + (4443.45)^2}$$

$$= \frac{4443.45 \pm \sqrt{4m^2 + (4443.45)^2}}{2m}$$

This equation may be solved by trial, substituting different values for m until one is found that is satisfactory. A value of 15,000 ft. gives the following solution:

$$e^{2213.5/15{,}000} = \frac{4443.45 \pm \sqrt{900{,}000{,}000 + 19{,}744{,}267.9025}}{30{,}000},$$

or 1.15902 = 1.5891, very nearly.

It may therefore be said that the new value of m corresponding with the contracted length is 15,000 ft., and the following equation will be true:

$$y_1 = \frac{15{,}000}{2}\left(e^{2213.5/15{,}000} + \frac{1}{e^{2213.5/15{,}000}}\right)$$

$$= 7500\,(2.02181)$$

$$= 15{,}163.57 \text{ ft.}$$

With this value the tension at the supports becomes

$$T_2 = \omega y_1 = 1.2 \times 15{,}163.57$$

$$= 17{,}206.25 \text{ lbs.,}$$

which is equivalent to a unit tension of (17,206.28/0.601) = 28,628 lbs. per sq. in. This

is an increase of $(28{,}628 - 26{,}333) = 2295$ lbs. per sq. in. above the tension at the summer sag. The new sag is $y_1 - m = 15{,}163.57 - 15{,}000 = 163.57$ ft., and is less by 5.32 ft. than the sag at a temperature of 130 deg. F.

Effect of Sleet or Ice Coating.

While it is in winter that the tension in a suspended wire or cable is increased due to contraction, it is also in the winter that a coating of sleet or ice tends to form on the wires and add another increment to the already increased tension. The weight of a cubic foot of sleet or ice may be assumed to be 57 lbs. It will be assumed that ice forms a coating over the outside of the suspended cable 0.5 in. in thickness, the diameter of the cable being 0.875 in. The volume of ice coating over a foot of the cable may be found as follows:

The cross section of the cable $= 0.25\pi(0.875)^2 = 0.5659$ sq. in., and the cross section of the cable and coating $= 0.25\pi\,(1.875)^2 = 2.7610$ sq. in. Cross section of ice coating $= 2.7610 - 0.5659 = 2.1951$ sq. in. The volume of ice per foot of cable is therefore equal to $12 \times 2.1951 = 26.34$, or very nearly 26.4 cu. ins. Since 1 cu. in. of ice weighs 57/1728 lbs., 26.4 cu. ins. will weigh 0.87 lbs. The effect of the ice coating is the same as increasing ω. In other words, the weight per foot of ice coated cable is $1.2 + 0.87 = 2.07$ lbs. The new tension is

$$T_3 = 2.07 \times 15{,}163.57 = 31{,}388.9 \text{ lbs., and the tension per sq. in.}$$

of cable becomes $31{,}388.9/0.601 = 52{,}227.7$ lbs. per sq. in.

Calculation of Increase in Tension Due to Wind Pressure.

Whenever a suspended cable is exposed to the action of the wind the tension is increased. The action of the wind is moreover greater in the winter than in the summer, due to the fact that the wind blows hardest at the same time that the cable is increased in effective size and weight by a coating of sleet or ice. It will now be instructive to compute the effect of the wind when acting in conjunction with the weight of cable—a coating of sleet and contraction due to low temperature. Of course, the greatest effect of wind at any velocity is produced when the direction of the wind is perpendicular to the length of the wire.

It is customary to consider in the case of a round wire that the effective area acted upon by the wind is the projected area of the wire. Therefore the area acted upon by wind in the case under consideration is $1.875 \times 12 = 22.5$ sq. ins., or 0.156 sq. ft., for each foot in length. A wind having a velocity of 30 mi. per hr. is assumed to exert a pressure of 15 lbs. per sq. ft. on a surface held perpendicular to its direction. If a 30-mi. breeze is blowing perpendicularly against the sleet coated cable, a pressure of $0.156 \times 15 = 2.34$ lbs. will be exerted against it for each foot in length. The pressure exerted by the wind swings the cable to one side and tends to hold it in that position so that the force due to the wind, acting at right angles with the direction of the weight of cable and sleet, constitutes one component of the total force that acts to produce the tension in the cable as indicated in Fig. 2. The resultant of the wind action and the action of gravity may be expressed by

$$R = \sqrt{(W_t)^2 + (W_d)^2}$$

from which, by substituting the proper numerical values,

$$R = \sqrt{(2.07)^2 + (2.34)^2} = 3.12 \text{ lbs.}$$

The actual tension at the support therefore becomes

$$T_4 = 3.12 \times 15{,}163.57 = 47{,}310.33 \text{ lbs.}$$

when the three forces due to weight, temperature and wind act concurrently. It is evident that the force due to wind constitutes a large

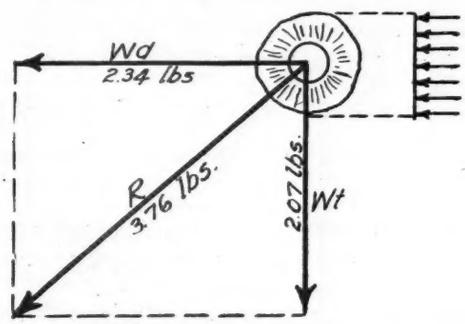


Fig. 2.—Diagram Showing Combination of the Forces of Wind and Weight of Coated Cable.

proportion of the total effect, especially as its velocity increases. For the case being considered the tension per sq. in. becomes

$$47{,}310.33/0.601 = 78{,}718 \text{ lbs.,}$$

a value above the elastic limit, so that a greater sag must be allowed if the installed cable is to be subjected to the conditions considered and be safe.

Comparative Effects Due to Ice Coating.

A coating of 0.5 in. of sleet on a wire 0.25 in. in diameter has a very different proportionate effect than a 0.5-in. coating of sleet on a wire 0.5 in. in diameter, both wires being of the same material. The volume of the coating per foot on a 0.25-in. wire may be expressed by the equation

$$V_1 = l\left(\frac{3.1416}{4} \times \frac{25}{16} - \frac{3.1416}{4} \times \frac{1}{16}\right) = l\frac{3.1416}{4} \times \frac{24}{16} = k \times \frac{24}{16}$$

The volume of the coating per foot on a 0.5-in. wire may be expressed by the equation

$$V_2 = l\left(\frac{3.1416}{4} \times \frac{9}{4} - \frac{3.1416}{4} \times \frac{1}{4}\right) = l\frac{3.1416}{4} \times \frac{8}{4} = l\frac{3.1416}{4} \times \frac{32}{16} = k\frac{32}{16}$$

Since the weights of the coating per foot are

proportional to the respective volumes the following proportions must be true:

$$\frac{W_2}{W_1} = \frac{V_2}{V_1} = \frac{k\,32/16}{k\,24/16} = \frac{32}{24} = \frac{4}{3} \text{ and}$$

$W_2 = \frac{4\,W_1}{3}$, showing that the weight per running foot, or for the whole cable, of ice coating on the 0.5 in. wire is 1.333 times that on the 0.25 in. wire.

The proportionate areas exposed to wind pressure may be compared as follows: The projected area in sq. in. per ft. for the 0.25 in. wire, when coated, is,

$A_1 = 12(5/4)$, while for the 0.5 in. wire
$A_2 = 12(3/2) = 12(6/4)$. Therefore,

$$\frac{A_2}{A_1} = \frac{12(6/4)}{12(5/4)} = \frac{6}{5},$$

or $A_2 = (6/5)A_1$. That is the coated 0.5 in. wire exposes 1/5 more surface than the coated 0.25 in. wire.

METHODS USED IN CONSTRUCTION OF STEEL-MILL MOTORS.

Excessive Heat and Hard Service, Including Rapid Starting, Stopping and Reversing, Demand Special Features of Construction.

In the steel plants the load characteristics of electrically driven auxiliaries such as mill tables, screw downs, tilting tables, etc., are such as to require, on the part of both motors and control, a high degree of ruggedness with a facility for rapid starting, stopping and reversing. Frequently, in addition to the mechanical strain of sudden acceleration, a motor is subjected to severe physical shocks which are transmitted through the gears when driving such auxiliaries as manipulator fingers or side guards. In addition to these severe operating conditions, the motors must be able to stand a high degree of heat. The designer must not only provide for a strong, rigid motor, but must also provide for a motor with the least possible inertia. A brief description of the steel-mill motors made by the General Electric Co., Schenectady, N. Y., will illustrate the practices that are adopted to provide equipment for this service.

In order to reduce the flywheel effect to a minimum and still have a strongly constructed armature, which means a heavy one, the armatures are made long and of small diameter, so that the peripheral velocities are low and extremely rapid acceleration is possible. As a result the power needed to accelerate the armatures to full speed is only from one-third to one-fourth that required for ordinary motors of the corresponding horsepower and speed. One of the principal difficulties to be overcome is excessive heating, especially in the types of motors which are totally inclosed. This is overcome by using mica and asbestos-insulated bars for the armature coils together with sheet mica in the slots and mica tape on the ends. Further protection from heat is secured by ventilating ducts in the punchings and by a complete ventilation system in the case.

Since motors doing this class of work are subject to frequent minor troubles, it has been found that a motor that can be taken down and overhauled without disturbing the rest of the machine to any extent possesses considerable advantages over one that cannot. To meet this condition steel-mill motors are so constructed that they can be inspected or repaired with the greatest facility. The case is made in two halves so that the whole upper half, pole pieces and all, can be thrown back or lifted off to expose the armature and bearings. Connections from one

Steel-Mill Motors Operating a Live Table and the Screw-Down on a 36-in. Blooming Mill.

half to parts in the other half are made outside the motor by flexible loads brought out through rubber bushings. The commutator is mounted on the armature spider so that the shaft can be removed without disturbing the connections between the armature and commutator bars.

As stated before, the rapid starting and stopping and reversing from speeds as high as 500 to 1000 r.p.m. put a considerable mechanical strain on the armature and commutator. For this reason, instead of using binding wire on the armature, the coils are held in place by a heavy binding band and clamps, and the connections from the armature to the commutator are made by letting the ends of the coils straight into solid ears on the commutator bars without the use of separable leads.

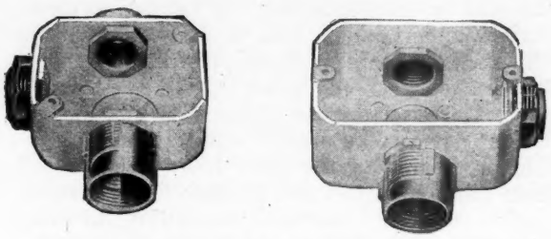
Controls for motors working under these conditions must share the same qualities of ruggedness and reliable operation under severe conditions as the motor. When motors are being reversed at a rate as high as 15 reversals a minute, the contactors come in for hard service and wear. Starting panels designed for use in steel mills are supplied with devices, contactors, etc., as simple in construction as possible, and so designed as to raise the factor of safety to the highest degree. The double-pole main line switch should be so designed that it may be locked open to prevent all accidents, and the reversing contactors should be mechanically interlocked. The master switch should be totally inclosed and built to stand the severest sort of service.

Conduit Bodies Standardized by Manufacturers

Adoption of Three-Unit Line of Conduit Bodies Reduces Time Required to Estimate Cost and to Purchase Fittings — Permits Smaller Stocks to Be Carried and Time Saved in Construction

The most recent and altogether important example of standardization that has occurred in the electrical industry is that which has just been made by the Outlet Box Section of the Associated Manufacturers of Electrical Supplies in standardizing fittings for wiring devices. Being applicable to every electrical installation, and, therefore, affecting the work of every electrical contractor, lineman and electrical worker, the step toward complete standardization will attract attention.

The accomplishment consists in the production of a three-unit line of conduit bodies for exposed



Shallow and Deep Bodies With Couplings in Place.

wiring that is of universal application for 0.5 and 0.75-in. conduit, armored conduits and any of the numerous wiring devices produced by the various manufacturers. Because of its simplicity, universality, rigidity, adaptability and other features, this line will be received with gratification by those who are interested in minimizing stocks or engaged in installing exposed conduit wiring. By its use the limitations imposed through the necessity of using special wiring devices should be eliminated. Hereafter, the man who is estimating on a wiring job or planning an installation can proceed with three basic conduit bodies and a few accessory covers and connectors with the assurance that he can accommodate any standard socket, receptacle or other wiring device or branch-line conduits in any direction at will. The large number of knockouts in each body makes its installation unusually elastic.

Contractor and Consumer to Profit by Standardization.

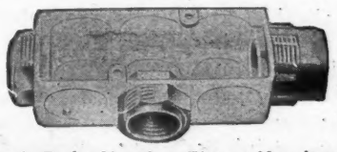
The production of the new conduit bodies is a distinct contribution to the electrical industry that demonstrates an unusual spirit of co-operation on the part of manufacturers. The principal benefit from it will accrue to the consumer and contractor. The contractor will benefit from the amount of time that can be saved on a job by being able to select fittings that will actually fit together. Moreover, should his stock be reduced so that he does not have on hand a full line produced by any one manufacturer, he can piece out by using the devices of several manufacturers. The consumer, on the other hand, will receive the benefit of interchangeability of parts when repairs are needed, and without scrapping perfectly good portions of his installation.

A broad range of conduit-body requirements has, in this new line, been combined into three bodies, two couplings and a few cover plates. The bodies and covers are stamped out of heavy sheet steel and are therefore unbreakable. All three bodies are universal, but the various plates are standardized to accommodate in a minimum number the large variety of standard receptacles, switches, etc., ordinarily used on walls and ceilings. The plates are mounted on the bodies and attached by means of special pointed screws furnished with the plates. These screws are turned into the device mounting bridge in the same manner now standard for the mounting of wall plates. Points on the screws are intended to assist the mechanic in locating the screw holes.

Standardized Conduit Bodies, Couplings and Cover Plates.

The three bodies of the line are denoted as branch, shallow and deep bodies. Branch bodies are longer than they are wide and are intended for use for junctions, taps, terminals, drop-cord work, etc. Shallow bodies are designed for similar use, and, in addition, for the reception of practically all kinds of wiring devices except those of the flush type. Deep bodies are designed for the reception of all standard makes of flush devices. These devices are mounted into the body in the same manner that is now standard practice in connection with switch boxes and wall cases.

Outlet blanks are provided in several places in all three types of bodies. The branch bodies have three blanks on each side and bottom and one in each end, and the shallow and deep bodies have one in each side and in the bottom. All



Branch Body Showing Eleven Knockouts.

knockout holes, except screw holes, are of one size, which accommodates both the 0.5-in. and 0.75-in. coupling and also the "BX" connection. The two latter bodies have four additional 0.25-in. knockout holes on 1.5-in. centers symmetrically located about the center of the bottom side. These additional holes are intended for use with

fixture studs or for fastening the boxes to walls or to machine frames. Securing the bodies to the walls is not often necessary, however, since the rigidity of the bodies and their support by the conduits is sufficient to meet the Underwriters' requirements. This additional security would be desirable in case the bodies were attached to flexible cables. For attachment to flexible cables a new 0.75-in. "BX" connector is used or the ordinary "BX" connector may be employed in conjunction with the 0.5-in. rigid-conduit connector.

The total number of covers manufactured are 16 for the branch bodies, 24 for the shallow bodies and 15 for the deep bodies. This is not a large number considering the number of different kinds of wiring devices in use. Cover plates will, of course, receive the devices produced by all manufacturers.

Adjustment of the bodies to 0.5 or 0.75-in. conduit is obtained by means of the connectors. The 0.5-in. connector consists of an inner nipple

Couplings for Attachment of Conduit to All Bodies.

and an outer locknut, and the 0.75-in. connector consists of an inner nipple in an outer sleeve. The projecting end of the former nipple is threaded to receive a 0.5-in. pipe, and the sleeve of the latter is threaded to receive a 0.75-in. pipe. The knockout is placed so that, when the locknut or sleeve is tightened, the octagonal nut on the nipple bites into the inside corners of the body to form a rigid connection.

Arrangements of the knockouts and the method of attaching conduits provide several characteristics that are valuable besides those enumerated heretofore. Regardless of the thread length on the conduit, the tightened system remains rigid after the body is secured by tightening in the locknut or sleeve and turning in the conduit. Confusion resulting from the installation of right and left-hand bodies is eliminated because each body is a right or left-hand or a "T" body as is desired. Moreover, a body can be inserted in or removed from a system at will without destroying the existing system except for the necessary reconnecting of the wires. Any additional circuits can be added after an original installation is made, to the limit of the body, by the simple expedient of removing the blank from the knockout, connecting the conduit and joining the necessary wires. Couplings are made of a special malleable iron as a guarantee against cracking or breaking from excessive stresses arising when the nuts are being set or the conduits are being turned home. Like the rest of the line they are electrogalvanized to resist rust.

The new conduit-body line, which is not patented, is being exploited independently by several manufacturers. Among those most actively engaged in the exploitation are Sprague Electric Works of General Electric Co., Steel City Electric Co., Thomas & Betts, and the Pratt Chuck Co. Although the conduit bodies are identical, these companies have adopted separate trade names for their product which are, in the order of the preceding names, "Spraguelets," "Wirelets," "T & B Conduit Bodies," and "Pratt Conduit Bodies." In order that no confusion may arise in the trade as a result of offering virtually one design under four different trade names, the competitive manufacturers promoting the idea are adopting a common symbol in their publicity featuring a hand holding up three fingers and bearing the inscription "Three Conduit Bodies That Replace Thousands."

NEW NATIONAL ELECTRIC SUPPLY PLANNED FOR HOLLAND.

Co-operation Between the Government and Existing Central-Station Companies Provides for a United System.

An extensive scheme of electrification has been prepared to embrace practically the whole of Holland with a view to helping that country deal with the difficult situation that arises in connection with industrial undertakings, owing to the high cost of coal. As the accompanying map shows, the scheme includes a network of high-tension transmission lines. Great economies are expected by concentrating the various central-station undertakings into a national scheme which will be useful in developing the smaller industries all over the country. The estimated cost of the scheme as planned is 125,000,000 florins ($42,000,000 present value). A considerable proportion of the plant has to be ordered from other countries and English firms have already received contracts amounting to over $5,000,000.

The activities, under the new scheme, of the several central-station companies which are already affording a supply in various localities will be allied to those of the government, the former being responsible for 10,000-volt and the latter for 50,000-volt distribution.

Figures shown in the accompanying table illustrate the very considerable increase that has

MAXIMUM DEMAND AND OUTPUT OF CENTRAL STATIONS IN HOLLAND.

Year.	Demand in Kw.	Output in Kw-Hrs.
1913	45,600	114,000,000
1914	53,600	134,000,000
1915	69,600	173,000,000
1916	88,400	221,000,000
1917	90,000	216,000,000
1918	100,000	240,000,000

taken place in the consumption of electrical power in Holland since 1913.

To meet present requirements the government committee reporting on the scheme is of the opinion that it is necessary to arrange for a total load on the electrical power stations of 300,000 to 400,000 kw., giving a total capacity of 1,000,000,000 kw-hrs. per annum. Such a supply will mean, with an anticipated population of 10,000,000 inhabitants in the next 30 years, a consumption of 100 kw-hrs. per person per annum, as compared to 35 to 40 kw-hrs. at present. This will compare with a present approximate consumption in the United States of 176 kw-hrs. per person, 140 for Switzerland, 60 for England, and 50 for Germany. This estimate does not take

into account the electrification of railways and the replacing of all steam traction by electric traction, for which it is provisionally estimated that 250,000 kw. will be necessary, although not more than one-third or one-quarter of this amount will be required for the next 15 years.

As to the execution of the project, the construction of the transmission lines for the whole country may take from five to ten years. For the high-tension network three-phase current at a frequency of 50 cycles is to be adopted, the minimum voltage being 50,000. The capacity recommended for the power stations supplying the system is approximately 30,000 to 75,000 kw. Each station will be equipped with generators developing 15,000 kw.

Legislation Required to Initiate Work.

As the first step in the scheme, certain legislation is necessary to empower the government to take over, as stated above, those central-station companies which are necessary for incorporation in the scheme. These include the power station Geertruidenberg, with the 50,000-volt lines in the province of North Brabrant belonging to that power station, and the recently built power station of the municipality of Amsterdam.

It is also recommended that the construction of high-tension lines should commence immediately in various districts. The cost of the work as above outlined is estimated at 35,000,000 to 40,000,000 florins ($12,000,000 to $14,000,000).

It is proposed to establish a special administration for the organization of the services. From among several alternatives there has been selected, for preference, a state enterprise under which the supply of electricity is to be a direct governmental service endowed with a large measure of freedom. Working agreements will be made as to the supply of current and the sharing of profits with municipal and other companies administering the scheme.

Preliminary General Design Completed.

Four out of eleven parts of a report on technical points have been issued by a committee formed by the Society of Directors of Electricity Supply Companies in Holland. The first of these four parts deals with the question of determining the locations of the high-tension transformer stations. The committee has calculated that for loads of from 18 to 52 kw. per sq. mi., the feeding of the 10,000-volt cables with 50,000 as well as with 100,000 volts will be secured in the most economical way if transformer stations are 12.5 to 18.5 mi. apart. About 50 transformer stations will be necessary for the country, and they will be an average distance of 15.5 mi. apart.

In the second part of the report the feeding of the high-tension transformer stations, determining the tensions, area of wires, etc., is considered. The average distance of the feeding points of the 10,000-volt distribution cables having been fixed, there remains the question of tension and the cross-section of the high-tension lines which have to feed the 50 transformer stations. Calculations are based upon the supposition that the transformer stations are situated at regular distances of 15.5 mi., and that they are all equally loaded. The results of these calculations are shown in graphs, added to the report, thus indicating the tension and sectional area of the lines. These graphs also show that, for large but sparsely populated districts, a very high voltage is most economical, while for heavily loaded industrial centers a lower voltage is to be preferred. It is furthermore evident from this report that the concentration of the generation of power has its limits, and it will be preferable, above a certain

Diagram of Proposed Transmission Network for Holland.

amount of power (30 to 50,000 kw), to erect more power plants instead of making a heavier high-tension distribution system. The third report deals with the scheme from the point of view of national defense.

In the last of the four sections the transmission of electrical energy from the mining district is outlined. It is here stated that, in addition to feeding the transformer stations, the high-tension lines should also be capable of performing other functions. They should, for example, be able to transmit energy in the shape of electricity from places where for some reason or other the costs of generating power are very low.

ECONOMIC VALUE OF THE CENTRAL-STATION INDUSTRY.

Retiring President of Ohio Electric Light Association Makes Noteworthy Comment at Recent Convention.

A year ago most central-station executives were buoyant with the satisfaction that the armistice had been signed to bring an end to the world war, and were cheerful at the outlook that soon the troublesome times would be past, stated C. H. Howell, of the Ohio Service Co., Coshocton, in his presidential address before the Ohio Electric Light Association at its recent convention. It was little expected that there would still exist the same vexatious problems concerning material, fuel and labor shortage, accompanied

by a credit situation rarely if ever before experienced by the industry. It is not pleasant to contemplate, but nevertheless every indication discernible upon the face of things today points to another year with quite as many trying situations as in the recent past. However, comfort may be taken and new resolve made upon the fact that throughout these years of war time and its consequent reconstruction period, with difficulties at the time seemingly insurmountable, the central-station industry has not failed, but has delivered in full measure the service that was expected as well as demanded.

Utilities a Great Factor in the Industrial Life of the Country.

The business as a whole continues to show remarkable growth, which proves even more conclusively that the utilities are among the greatest factors in the country's industrial and commercial life. It seems to have needed only the melting pot of a world war, with all its calls for maximum production, to cause the burning out of a dross of blind prejudice and to expose in undisputed light the true economic value of central generation and distribution of electric light and power for all industrial, commercial and domestic uses.

Tremendous calls upon the electric utilities during the war for increased output, attended since by unfavorable money market conditions, brings about a situation that can best be described in plain words as a veritable power shortage. Typical American inventive genius did not relegate the war plant to the scrap heap in large part, but, rather, quickly converted it into a peace-time manufactory, with the result that station capacity sold in war time remains sold now in peace time. This situation can now be relieved only by the installation of larger generating units and the investment of tremendous amounts of new capital.

Rates Should Be Sufficient to Attract Needed Capital.

High rates of interest at which money may be had has undoubtedly been a deterrent factor in the response of the utilities in promptly providing larger equipment to supply the increasing needs of their customers for power. The sound principle which prohibits regulated monopolies from earning at any time more than a fair return on their capital investment also demands that at no time shall the earnings be less than a fair return. It is believed that the regulatory bodies, empowered by the laws of Ohio, will speedily rectify the situation in this state, at least to the extent that utilities may earn a return equal to that necessary to attract needed capital if they must at the same time compete with other unregulated industries who earn more and consequently pay more for new capital. By the very nature of things, commission regulation should make public utility securities attractive, and they are attractive. But when competition increased the price of money, public utility securities limited to a fixed return sought their own level, which is low at present and cannot be raised again until relief comes. The public should be fairly and fully informed of the present status of the industry with all its powerful possibilities for general public service; to cripple or handicap utilities in their present needed development would actually be nothing short of a national calamity.

New Developments Anticipated in the Central-Station Industry.

Throughout this wonderful industrial state of Ohio there seems about to emerge another epoch in the economics of power generation and distribution, in the form of one or more tremendously large generating stations with a super-transmission system. When this does come about it will again call for large volumes of capital, but which seems amply compensated for, however, by tremendous savings in fuel and labor. The question of fuel bids fair to become a very major item of expense, and if greater economy in its use for a given output is not developed further inevitable increase in rates must be had. Such a development as this would undoubtedly convert many of the smaller stations to local standby units, but at the same time it would relegate to the past further serious consideration of independent municipally owned electric plants.

With the already large network of transmission lines over the state another most insistent demand is heard. It is electric service for farmers. It inherently has a low load-factor and high seasonal demand, necessitating line construction and causing serious rate complications. But the farmer cannot be ignored or denied this service. He has already discarded the messenger for the telephone, and the old one-horse shay for the automobile, and now he seems determined to have more of the convenience of the cosmopolitan center, including electric light and power, and, in all reasonable expectation, he will get it. By many companies the farmer demand for service is being considered very seriously in spite of the uninviting rate and maintenance complications.

Customers Are the Best Security Holders for Public Utilities.

Under the present order of things in this state, central-station companies are required by law to consult with their customers, through the medium of newspaper advertisements, before rates can be raised. Here again it is becoming more and more a recognized fact that the best kind of public ownership of local utilities is accomplished by a wide distribution of that utility's securities among local customers. This form of co-partnership leads to a more complete understanding and co-operative effort in its development, and retains in the management and operation of the utility those trained by long experience to perform the task in its most successful way. The public in the communities served has the right to know fully and frankly all of the difficulties that beset the utility companies, certainly insofar as it affects the service and its cost. Finally, the confidence, co-operation and civic pride of the public in the utility may most easily be had when it shall have been proven to them that the utility company is the biggest asset and the best citizen in the town.

EDITORIAL COMMENT

Trend of Practice in Electrical Construction

The rate of growth and extension of high-voltage power systems in this country during the last ten or fifteen years has been astonishing, and that notwithstanding the check on development caused by the world war and certain unfortunate regulations which, until quite lately, have prevented the establishment of hydroelectric power stations on many desirable sites. Nevertheless, it is always in order to ask the question: Have we developed along the best possible lines, and are we at the present time considering the whole field of electric power development and distribution with the open and far-seeing attitude of mind which should be adopted when so important a matter is under consideration?

These thoughts are suggested by the article in this issue dealing with "Systems of Electric Transmission," in which Prof. Still deals broadly with many matters of immediate concern to the electric power industry.

It is perhaps true that the three-phase system feeding transformers on parallel circuits through high-voltage transmission lines is best adapted to present conditions in this country if not in all countries; but the Thury system of direct-current transmission on the series principle, with constant current and variable voltage, is in successful operation in Europe and would seem to deserve more study than is usually devoted to it. That there are objections to it is not to be denied, but every system has its disadvantages which must be set against its advantages, and it is possible that, even in this country, occasions may arise when some departure from the general practice of today may be not only desirable in connection with a particular undertaking, but may have an important bearing upon future developments.

It is questionable whether we, in our prosperity and attention to the immediate demands on our time and engineering knowledge, devote sufficient thought to this and similar questions remote from routine and details of our daily work.

In the article referred to, some reference is also made to transmission frequnencies in this and other countries. We have grown accustomed to contemplate with equanimity, if not with a certain tenderness born of long familiarity, the several frequencies among which the 25-cycle and 60-cycle have been dignified by being referred to as "standard." Are these all that they should be and do they satisfy our present needs and promise to give us the same satisfaction in the future? We do not know, but the question is not impertinent.

Prejudice

Electrical engineers in this country are not addicted to the study of the engineering practices and tendencies of other countries. There are reasons for this. Conditions on the American continent differ considerably from conditions in Europe, and, in various degrees, from those in other parts of the world. This is perhaps not a very good reason for taking little or no interest in the problems confronting the electrical industry in countries other than our own; but in view of the fact that there is much to be done at home and that we are continually devising new and improved methods and machinery, it is not to be wondered at. We are too busy to bother our heads about what the other fellow is doing. Then again, we have been the leaders—pioneers.

The electrical industry, not hampered by unconsidered, unreasonable or reasonless legislation to the same extent here as in some of the older countries, has forged ahead with great strides, and we feel perhaps that we have nothing to learn from our colleagues on the other side of the Atlantic. The summation of all such feelings and failings amounts in the end to the condition or attitude of mind which is usually referred to as prejudice. It is just possible, though by no means proven, that we are prejudiced in favor of three-phase, alternating-current systems with transmission by overhead wires—preferably at pressures in the neighborhood of 200,000 volts, using frequencies of 60 cycles or 25 cycles (or both)—and that, in the matter of motors and distributing systems, we are prejudiced in favor of an unlimited number of sizes, types and voltages.

Prejudice in other countries runs along different lines. Without attempting to study the engineering and industrial problems peculiar to England—which might or might not be a waste of valuable time—it is certainly interesting to find that in connection with the proposed superpower stations in the coal-mining districts to generate power for use in the industrial centers it is seriously contemplated to use underground cables for the main transmission lines. Here prejudice

unquestionably plays an important part; but we, on our side, are unable to appreciate the situation without first studying the conditions peculiar to the generation and distribution of electrical energy in England. When we think of long-distance transmission we conjure up a mental picture of steel towers spaced 800 feet apart, carrying hundreds of miles of wire over trackless deserts or wind-swept mountain ranges; but in England the term long-distance transmission is applied to distances rarely exceeding 15 to 20 miles. Let us therefore not be too quick to criticize unfavorably; without a thorough understanding of European conditions we are not competent to do so.

Many British engineers are familiar with electric power conditions in India, Africa, and other parts of the world, and a few have a thorough knowledge of the conditions in this country. How, then, is the investigation conducted which is to bring out the relative qualities and defects of the underground and overhead systems of transmission? It appears to be done in this way: On the one hand are lined up those interested in the manufacture of underground cables, supported by the engineers of the power companies who have no knowledge of overhead systems, while on the other hand stands a minority consisting of manufacturers interested in the sale of steel towers and insulators together with those engineers who have had experience with overhead transmission and appreciate its virtues. And after these people have been brought together in the same room the discussion begins. This is clearly in accordance with precedent and custom; engineering decisions of great moment are generally arrived at in this manner. Still it cannot be denied that prejudice plays an important part in determining the final outcome in many instances.

One speaker at a recent conference in England where the relative merits of overhead and underground systems were discussed expressed the opinion that if British engineers were prejudiced in favor of underground mains they were rightly so prejudiced because he (the speaker) believed that the service was more reliable with underground than with overhead conductors. In this instance no attempt was made to camouflage the fact that prejudice is a factor in determining a policy or in arriving at a decision of momentous importance.

In the field of engineering there should be no room for prejudice. Facts and statistics, sorted and weighed by the trained intellect of the engineer, should determine his decisions. Knowledge is therefore essential—a wide, all-embracing knowledge, together with the judgment (not the pre-judgment) of the experienced engineer, without which such knowledge would be useless and worthless.

Did the speaker who had a feeling that underground cables were always more reliable than overhead wires *know* that recent cable failures on some of the underground networks serving large industrial and residential districts in this country involved an aggregate property loss exceeding one million dollars? We doubt that he had heard of these cases.

We hold no brief for either overhead or underground transmission, and we are certainly not competent to settle the peculiar problems of our friends in Europe; what we wish to emphasize is not the superiority of one system over another, but that the engineer, when he finds his prejudices are beginning to master him, should do something to overcome them.

Standardization of Outlet Bodies

Standardization has probably done as much to advance the electrical industry to its present position as any other single agency. And still there remains many dimensions, devices and practices to be agreed upon before it can be said that the materials and practices of the industry are standard. The most recent materials to be considered and actually reduced to standard types and dimensions are the outlet boxes, or bodies as they are now called, of a number of prominent manufacturers.

Three new bodies are being substituted for the great variety of boxes now manufactured in various shapes and sizes and of various materials. It is evident at once that such a reduction in types will allow the manufacturer to reduce some of his shop and overhead costs. At least it will be an offset against general advancing costs of all manufactured materials. It is also evident that the jobber, dealer and contractor will be able to operate with a smaller stock and so with reduced overhead costs. The actual work of installing equipment will be reduced by the elimination of wrong delivery or the installation of materials that almost fit.

The conduit-body manufacturers are to be congratulated on their success in actually establishing a set of standard types and sizes. If future experience indicates the need, the sizes or shapes may be modified, but the big point is that the start has been well made. Other manufacturers may well take up the work of harmonizing their equipments for the good of the user. Such standardization when well considered can only stimulate healthy business and result in good to stimulate healthy business and result in good in every line of the many that mark the industry.

THE WEEK'S NEWS

Reports of Important Meetings, Developments and Other Happenings of the Electrical Industry and Its Allied Interests

PUBLIC UTILITIES STILL UNABLE TO PILE UP COAL.

General Improvement in Situation Is Shown in All Parts of Country But Demand Is Still Far in Excess of Supply.

Conditions regarding coal supply for public utilities, while less acute than three weeks ago, are still grave and in few, if any, instances are utility companies getting a sufficient supply to enable them to pile up a reserve stock for the winter months. Rather, instead of doing this, many companies are using coal out of their reserve piles at the present time.

Miners in the Illinois field, who had been on strike, went back to work this week and thereby relieved the situation in the central district to some extent. In the Eastern section the mines are reported as being worked to capacity, but the car movement is still slow and none of the mines have all the cars needed to ship coal.

The Northwest and New England now have priority rights on coal shipments, the order on New England being made effective by the Interstate Commerce Commission Aug. 2. Neither this order nor the previous one covering Northwest points in any way affects the priority order recently granted to public utilities, but the lack of coal cars is having a hampering effect on the utility priority order and few companies are receiving the usual supply of coal.

An interesting viewpoint on the coal situation as it affects public utilities was given by John W. Lieb, vice-president of the New York Edison Co., who, in testifying before the United States Senate committee on reconstruction and production, said that the Edison and affiliated companies had contracts for 1,535,443 tons of coal, but that since April 1 had only been able to get 52% of the coal contracted for delivered. At this time of the year the companies usually have about 200,000 tons in storage yards but that the present reserve was a trifle under 50,000 tons. That the companies have this amount on hand is due to them going into the open market and buying "spot" coal. Mr. Leib said the Edison companies should be receiving 5800 tons of coal daily in order to build up the winter reserve. Instead of that the companies are receiving barely 4000 tons daily, which is about the average daily consumption.

In Detroit, the Detroit Edison Co. has been suffering from coal shortage to such an extent that a committee from the Detroit Board of Commerce, working in co-operation with the company and the users of power, has been at work cutting down the consumption of energy, through allotting a certain amount per day to each industry and also fixing the hours of the day in which the power may be used. By this means the company has reduced its morning peak load of 218,000 kw. to 156,000 kw. The former peak load of 218,000 kw. was beyond the capacity of the company as it has been forced to take a 45,000-kw. unit out of service to await the arrival of new parts from the manufacturer.

MICHIGAN SECTION, N. E. L. A., HAS LONG PROGRAM.

Seventh Annual Convention of Central-Station Men Will Be Held at Ottawa Beach, Mich., Aug. 24-26.

Addresses on legislation, the future of the electrical industry, and on publicity methods, combined with papers on various technical subjects, make up the tentative program announced for the seventh annual convention of the Michigan Section of the National Electric Light Association, to be held at Ottawa Beach, Mich., Aug. 24-26, with headquarters at the Ottawa Beach Hotel.

The convention will be opened with an address by W. M. Lewis, Muskegon, president of the Michigan section, and will be followed with an address on "Legislation" by W. M. Smith, chairman of the Michigan Public Utilities Commission. The plans outlined for the national body of the N. E. L. A. will be explained by Pres. Martin J. Insull, while M. H. Aylesworth, executive manager of the association, will deliver an address on "The Future of the Public Utility." The first session will end with an address by B. J. Mullaney, Chicago, chairman of the Illinois Committee on Public Utility Information.

The afternoon session will be devoted to the reading of papers and discussion of them, the papers being as follows: "Proper Maintenance of Electric Meters," by J. C. Langdell, Consumers' Power Co., Jackson; "Standardized Construction," by B. L. Huff of the same company; "Boiler Room Efficiency," by R. C. Felger, Detroit Edison Co. In the evening M. Luckiesh, Nela Research Laboratory, Cleveland, will give an illustrated talk entitled "Journevs in Cloudland," being a recital of Mr. Luckiesh's experiences in the world war when he was attached to the United States aviation forces.

On Wednesday papers will be presented on "Home Rule vs. State Control," by W. J. Hagenah; "Light in the Home," by M. Luckiesh; "Standardization and Application of Electrical Equipment as Applied to Farms," by Prof. A. R. Sawyer, Michigan Agricultural College; "Dishwashers and Other Labor-Saving Devices," by C. H. Bay, Detroit Edison Co. The Thursday session will consist of a paper on "Machine Billing and Ledger Posting," by C. H. Hunsberger, Consumers' Power Co., with discussion on the paper led by J. D. Jacobus, Detroit Edison Co.,

and a paper on "The Value of Statistics," by H. A. Snow, Detroit Edison Co.

The annual dinner of the section will be held Wednesday evening, at which time J. B. Wootan, New York City, will deliver an address on "Publicity." Special entertainment features have been arranged for the delegates for Tuesday and Wednesday afternoons.

ANNOUNCE MEETINGS OF N. E. L. A. TECHNICAL SECTION.

Committee Arranges Series of Sessions to Be Held in Various Cities During the Forthcoming Six Months.

The Technical Section of the National Electric Light Association has just completed its schedule of meetings for the next six months, 33 meetings being listed to be held in various cities throughout the country, the first one being at Spokane, Wash., Sept. 11, when the hydraulic power committee meets.

The complete list of meetings of the different committees of the section, together with the place of meeting and date follows:

Hydraulic Power Committee. — Spokane, Wash., Sept. 11; Salt Lake City, Utah, Nov. 18; New York City, Jan. 17.

Meters Committee.—Chicago, Sept. 20-21; Salt Lake City, Utah, Nov. 16-17; Buffalo, N. Y., Dec. 7-8-9; New York City, Jan. 18-19.

Prime Movers Committee.—Chicago, Sept. 20; Philadelphia, Oct. 18; Salt Lake City, Utah, Nov. 15; New York City, Jan. 18; Schenectady, N. Y., Feb. 21.

Underground Systems Committee.—Detroit, Sept. 20; Pittsburgh, Nov. 11; New York City, Jan. 17.

Inductive Interference Committee.—Chicago, Sept. 21; Salt Lake City, Utah, Nov. 15; New York City, Jan. 18.

Electrical Apparatus Committee.—Chicago, Sept. 22; Salt Lake City, Utah, Nov. 16-17; New York City, Jan. 19.

Overhead Systems Committee.—Chicago, Sept. 22-23; Salt Lake City, Utah, Nov. 16; New York City, Jan. 19-20.

All of the above meetings of the Technical Section committees will start at 10 a. m. A meeting of the executive committee of the section will be held in New York City, Jan. 19.

BURCHARD PREDICTS EXPANSION IN ELECTRICAL INDUSTRY.

Vice-President of General Electric Co. Believes Prospects in Foreign Trade Field Are Particularly Bright at Present Time.

Just before sailing for Europe on a business trip recently, Anson W. Burchard, vice-president of the General Electric Co., Schenectady, N. Y., said he believed the future outlook of the electrical industry was very good, not only in this country but in Europe as well.

In discussing the situation Mr. Burchard said that while he anticipated a great expansion in the electrical industry it would be rather slow in developing its full strength owing to the present unsettled conditions. The demand for electrical machinery, he said, has increased at a tremendous rate, particularly in view of shorter working hours and the decreased efficiency of labor. This naturally produces an increased demand for labor-saving machinery, and electrical machinery lends itself to relieve the situation better than anything else.

Speaking of foreign trade, Mr. Burchard said Italy offers a big field for the use of electrical machinery, but that her demands are more in the way of raw material, as they wish to do the manufacturing themselves. Expansion in Italy is handicapped to some extent by the inability of the industries to obtain credit. The General Electric Co. has an affiliated manufacturing plant in Italy which cares for considerable business. The company also has manufacturing plants in France, England and Belgium and they are working to capacity to keep pace with the orders, while in the United States the orders are in excess of the capacity of the company's plants.

Mr. Burchard expressed the belief that some sort of a plan for export financing, such as covered by the bill fathered by Senator Walter E. Edge of New Jersey, was necessary. He asserted that it was difficult for the United States to do business abroad extensively when the balance in trade is three or four billion dollars in favor of the United States. England and many other countries have built themselves up commercially by accepting the securities of other nations, he explained.

WESTINGHOUSE CO. AGENT-JOBBERS HOLD CONVENTION.

Over 100 Association Members Combine Business and Pleasure in Eight Sessions Held at Hot Springs, Va.

Important electrical merchandising problems and policies were discussed at the eighth meeting of the Westinghouse Agent-Jobbers Association, held at Hot Springs, Va., July 26-29. Approximately 100 members of associated companies and Westinghouse officials and representatives attended the convention.

Plans for improving merchandising methods were discussed at the business meetings. The value of advertising and its relation to merchandising was clearly emphasized in the report of J. C. McQuiston, advertising manager of the Westinghouse company. An elaborate display of advertisements illustrated the very carefully worked out plans of co-operation between manufacturer, jobber and dealer. Although much time was given to entertainment during the afternoons, numerous committee reports were submitted and important business problems were discussed during the morning and evening session.

F. E. Stow, treasurer and general manager of the H. C. Roberts Electric Supply Co., Philadelphia, was re-elected president of the association as a tribute to his effective leadership. J. J. Gibson, manager of the supply department of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., was elected vice-president.

The following officers were re-elected: C. C. Blackwell, secretary; H. T. Pritchard, assistant secretary; J. E. McClernon, treasurer; J. J. Jackson, counsel.

Competition for golf trophies lent zest to the entertainment features. C. B. Hawley, general manager of the Inter-Mountain Electric Co., Salt Lake City, Utah, was awarded the past-president's cup. G. H. Miller, general manager of the Tel-Electric Co., Houston, Tex., won the W. C. Free silver trophy cup for agent-jobbers. The executive committee trophy was won by T. J. McGill, Westinghouse company, Chicago district manager. Bernard Lester, assistant to manager of the industrial department of the Westinghouse company, East Pittsburgh, Pa., was the winner of the tennis tournament.

ELECTRICAL INSPECTORS TO MEET IN PHILADELPHIA.

The annual meeting of the National Association of Electrical Inspectors will be held in Philadelphia, Oct. 12-13. The headquarters of the association will be in the Underwriters' Association auditorium, where all sessions during the meeting will take place. The program is now being prepared under the direction of W. L. Smith, Concord, Mass., secretary of the association, and will be announced at a later date.

CLEVELAND ELECTRICAL LEAGUE HOLDS MEETING.

W. L. Goodwin Urges Co-operation and Organization at "Get Together" Meeting Held at Camp Nela, Nela Park.

Scientific organization and close co-operation whereby each group in the electrical industry would respect the function of the other was the theme of an address made by W. L. Goodwin at the "get together" meeting of the Electrical League of Cleveland, held at Camp Nela, Nela Park, O., July 22. Mr. Goodwin urged a better knowledge of fundamental business principles, the sale of the electrical idea so that more money would be forthcoming to finance a business that is growing by leaps and bounds, and greater standardization and scientific distribution in order that a majority of the people in the electrical business will be free to create new applications and appliances.

Ernest McClery, past-president of the National Association of Electrical Contractors and Dealers, urged greater specialization in the functions of manufacturers, jobbers, contractors and retailers and asked men in the industry to sell electrical service so that the goods once sold will stay sold. P. B. Zimmerman, publicity manager of the National Lamp Works of General Electric Co., is the president of the Electrical Club of Cleveland.

CONTRACTOR-DEALER CONVENTION PROGRAM ANNOUNCED.

Many Papers and Discussions of Interest to Industry Are Scheduled for Presentation at October Meeting in Baltimore.

Announcement of the tentative program for the twentieth annual meeting of the National Association of Electrical Contractors and Dealers, to be held at Baltimore, Oct. 4-9, shows that the members of the association will have a busy time at the Maryland city, although the actual opening of the convention sessions does not take place until Wednesday, Oct. 6.

Monday and Tuesday will be devoted to meetings of the executive committee, sessions being scheduled for morning and afternoon of both days. At the opening of the convention proper S. C. Blumenthal, chairman of the Maryland State Association of Contractors and Dealers, will deliver the opening address, and Mayor William F. Broening, of Baltimore, will make a welcoming speech with a response by W. Creighton Peet, chairman of the national association. A report on the industrial outlook will be made by a speaker to be announced later, followed by the report of Laurence W. Davis, special representative of the association.

On Thursday a paper on "Sale of Motors for Industrial Use" will be presented by J. A. Clark, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., followed by a discussion on "Successful Conduct of a Contracting Business," led by A. S. Abbott, Electric Construction Co., St. Paul, Minn. There will also be a discussion on "The Proper Handling of Fixture Sales," led by a speaker to be announced later Thursday afternoon will be devoted to a trip to Annapolis, Md., where the delegates will be greeted with an address by Gov. Albert C. Ritchie, of Maryland, after which a trip of inspection will be made to the United States Naval Academy.

The association members will get back to busi-

Members of Electrical League of Cleveland Who Attended "Get-Together" Meeting at Camp Nela, Nela Park, O.

ness again Friday, when the following papers will be presented: "A Two Billion Dollar Industry," by H. B. Kirkland; "Harmonizing the Industry," by Samuel A. Chase, and "Scientific Merchandising," by William L. Goodwin. The business sessions of the convention will be closed with a discussion on industrial lighting, led by W. G. McKettrick, National Lamp Works of General Electric Co., Cleveland.

On Wednesday evening there will be a reception and dance at the Southern Hotel, which will be the convention headquarters, and on Friday evening the annual dinner of the association will be held, to be followed by dancing. W. H. Morton, 110 West 40th street, New York City, is the general secretary of the association and has charge of the convention arrangements.

I. E. S. CHANGES DATE OF ANNUAL CONVENTION.

The date of the fourteenth annual convention of the Illuminating Engineering Society, originally set for Sept. 27-30, at Cleveland, has been changed to Oct. 4-7, in order not to conflict with the convention of the American Legion to be held in Cleveland during the last week in September. The committee in charge of the I. E. S. convention arrangements are as follows: General convention committee, J. E. North, Cleveland Electric Illuminating Co., chairman; reception committee, W. M. Skiff, Nela Research Laboratory, chairman; publicity committee, H. A. Green, National Carbon Co., chairman; entertainment committee, J. M. Smith, Ivanhoe-Regent Works of General Electric Co., chairman; finance committee, George S. Milner, Erner Electric Co., chairman.

ACCOUNTING COURSE COST REDUCED BY N. E. L. A.

Cut of $25 Is Made in Subscription Price of Advanced Course in Order to Introduce It to Many New Members.

For the purpose of introducing the advanced accounting course of the National Electric Light Association to as many member companies and their employes as possible the subscription price of the course for the fiscal year of the association, which began July 1, has been reduced from $65 to $40.

The suggestion of a reduction in price was made by President Martin J. Insull during the discussion of the report of the committee on education at the recent Pasadena convention and the suggestion has now received the approval of the committee and also of President Insull.

In announcing the reduction the committee on education states that the $40 price for the course can only remain the permanent price by a large increase in the number of subscribers. If the committee and the association do not receive the fullest indorsement by a greatly increased subscription to the course it will undoubtedly be necessary to return to the higher price.

It is expected that many companies will take advantage of the reduction on price to establish classes in advanced accounting and undoubtedly a large percentage of workers who took the elementary course last year will continue their study in accounting by subscribing to the advanced course.

The course consists of 36 lessons, and was established by the N. E. L. A. in response to a very evident demand for standard instruction in accounting for the electrical industry. It follows closely the practice of the most progressive central-station companies in the industry. The price of the elementary accounting course remains at $16 the same as formerly, while when groups of ten or more have the course sent to them at the same time the price is $14.

The success of the course in practical electricity and commercial engineering has warranted the reduced prices at which these courses are being sold and it is expected that with the large number of new companies and their employes taken into the N. E. L. A. during the past year enough subscriptions will be obtained to the advanced accounting course to allow it to remain at the reduced figure. For the benefit of the industry as a whole the association last year removed all restrictions as to enrollment in these courses and they are now open to all who may apply for them.

NORTH JERSEY POWER CO. HALTS POWER HOUSE PLANS.

The Public Service Electric Co., Newark, N. J., has temporarily abandoned its plans for the construction of a central power plant to furnish electric power service to industrial interests in northern New Jersey. The plant was to be operated by a subsidiary organization, known as the North Jersey Power Co., and it was planned to spend in excess of $5,000,000 on the project. In a statement announcing the abandonment of the plan, President Thomas N. McCarter says that the plant will be built at a later date.

COMING CONVENTIONS.

Michigan Section of the National Electric Light Association. Annual convention, Ottawa Beach, Mich., Aug. 24-26. Headquarters, Hotel Ottawa. Secretary, Herbert Silvester, Ann Arbor, Mich.

Nebraska Section of the National Electric Light Association. Annual convention Omaha, Neb., Sept. 8-9. Secretary, B. H. Conlee, Nebraska Gas & Electric Co., Beatrice, Neb.

Pennsylvania Electric Association. Annual convention, Bedford Springs, Pa., Sept. 8-11. Secretary, H. M. Stine, 211 Locust street, Harrisburg, Pa.

New England Section of the National Electric Light Association. Annual convention, Kineo, Me., Sept. 13-16. Secretary, O. A. Bursiel, 149 Tremont street, Boston, Mass.

Illuminating Engineering Society. Annual convention, Cleveland, Oct. 4-7. General Secretary, Clarence L. Law, 29 West 39th street, New York City.

National Association of Electrical Contractors and Dealers. Annual convention, Baltimore, Md., Oct. 4-8. Headquarters, Southern Hotel. Secretary, W. H Morton, 110 West 40th street, New York City.

National Association of Electrical Inspectors. Annual meeting, Philadelphia, Oct. 12-13. Secretary, W. L. Smith, Concord, Mass.

International Association of Municipal Electricians. Annual convention, New Orleans, La., Oct. 19-22. Secretary, Clarence R. George, Houston, Tex.

COMMERCIAL PRACTICE

New-Business Methods, Policies, Rates and Kindred Central-Station Matters for the Man Engaged in Selling Electricity

REGULATION HANDICAPS SALARIES PAID SALESMEN.

Utility Companies Cannot Meet Competition in Compensation Paid in Other Lines of Industrial Business.

In discussing compensation paid to lighting salesmen at the recent Pasadena convention of the National Electric Light Association, M. S. Seelman, manager of the commercial department of the Brooklyn Edison Co., pointed out that in the past there is little doubt but that the lighting salesmen of the average power and light company were not paid on a scale commensurate with the pay in competitive industries.

"That has been very easy to understand," said Mr. Seelman. "If a salesman in a wholesale clothing business, for instance, in New York City, achieves success and distinction in his line, there may be competition for his services among two or three hundred wholesale clothing concerns in New York City, and elsewhere.

"If, however, a central-station employe is competent above the average, and dissatisfied with the conditions in the city in which he is employed, there being as a rule but one lighting company in that city, he will have to seek some other city for an increase in his emolument or change in his service conditions. The fact of limited competition has naturally made for a somewhat smaller scale of pay. That condition, however, has been considerably modified, though not changed altogether, by the conditions brought about by the world war. There is such a demand for men of all kinds that the central-station salesman, who has learned the art of selling, has found it comparatively easy to obtain positions in many cases paying them better salaries in other vocations, some of them closely allied, and others not at all. And that has given an impetus or stimulus of competition to the central-station executives, or rather to the situation, so that in many cases in order to retain men of value it has been necessary to pay them considerably increased salaries."

Continuing, Mr. Seelman said he regarded this as rather a healthy situation as it was unfortunate that central-station companies were forced to train people in central-station organizations over a term of years for effective work, and at last when they become effective, and the company has put good money and time in training them, to lose them in large numbers. It was also pointed out that central-station companies are not as advantageously situated in connection with the payment of wages along modern lines as other lines of business that are competitive and not regulated. If the central-station company's rates are fixed, as they usually are, there is a limit beyond which salaries cannot be raised, and beyond that limit the company has to let good men get away from it to other lines of industry.

CENTRAL-STATION COMPANY GIVES AID TO CONTRACTORS.

United Electric Light & Power Co., New York City, Co-operates With Allied Lines in Industry in Advertising Campaign.

The advantages of close co-operation between central-station companies and contractor-dealers is being shown in New York City, where the United Electric Light & Power Co. is not only running a series of advertisements in the daily newspapers urging better wiring and use of more appliances in homes but is also affording financial aid to contractor-dealers, when necessary, to make such installations, especially wiring, possible.

There was a time
when cooperation between a Central Station and Contractor-Dealer was confined to a vague relationship of no particular value or benefit to either. The sharply contrasting spirit of mutual helpfulness that prevails today is indicative of the moral strength and progress that is accompanying the electrical industry's growth.
A house wiring campaign recently conducted by this Company, planned and executed with a view to mutual benefits, has justified every theory that best results come from earnest coordinated efforts.
We appreciate the interest and hustling that attended this campaign for new business and are encouraged to continue to support, as in the past, the local Contractor-Dealer in our future activities.
The United Electric Light and Power Co.
130 East 15th St., New York.
Branch Offices:
89th St. & Broadway
146th St. & Broadway

Pamphlet Sent to Contractor-Dealers in Advertising Campaign.

The campaign has been in progress for some time and according to reports made by both the central-station company and the contractor-dealers is working out most satisfactorily to both sides. Newly built structures, both office and residential, are being better wired and more out-

lets provided than ever before, while hundreds of old buildings are having the old-time wiring systems in them replaced with new and modern type of wire and outlets.

The United company has recently sent to all recognized contractor-dealers in New York City letters and illustrated pamphlets showing the scope of its advertising campaign and its plan of financial co-operation with the dealers and the response has been even greater than the company expected.

MUST CONSIDER THREE MATTERS IN POWER-FACTOR CONTRACTS.

Determination of Power Factor Upon Which a Penalty Shall Be Based Is Hard Problem for Central-Station Companies.

In presenting a paper on power-factor in connection with power contracts recently R. H. Ashworth, commercial manager of the Utah Power & Light Co., Salt Lake City, Utah, said: It appears that a large number of companies have not as yet taken any definite stand nor adopted a fixed policy in connection with standardizing on a method of considering the subject of power-factor in their rate schedules. Such a procedure seems desirable for several reasons; first, that all companies may be working along the same lines and toward the same end; second, that this matter may be presented to the state regulatory bodies in a uniform manner; and, third, that a standard method of metering equipment may have a definite end toward which to work in order to bring out a satisfactory meter at a reasonable cost which they know, when developed, will meet the requirements of the industry.

There are three matters in connection with adopting a standard power-factor provision in power contracts that must receive consideration; first, what shall constitute a reasonable power-factor; second, what method shall be used in determining power-factor; and third, what method shall be used in applying the penalty in the rate schedule.

From the practice of various central-station companies, from opinions expressed by various state commissions, from the reports of National Electric Light Association committees and particularly from a study of the effect of poor power-factor, it would appear that for the larger installations at least 85% should be considered a reasonable power-factor and that any power-factor lower than this should be penalized in figuring rates.

The question of the method of determining the power-factor upon which a penalty shall be based is likely open to more discussion than either of the other two questions involved, said Mr. Ashworth, who personally feels that an average power-factor determined monthly by the use of two standard polyphase watt-hour meters should be the one used and a penalty applied on the basis of such determination.

An average power-factor determined as above will result in a lower power-factor and a greater penalty than, for example, the power-factor determined at the time of occurrence of the maximum demand since the power-factor so determined will likely be the highest power-factor established by the consumer. A correction for power-factor based on the power-factor established at the time of maximum demand does not appear fair to the company since it does not take into consideration very low power-factors which may occur at times of light load nor on the other hand does a correction based on the power-factor established at time of light load seem to be fair to the consumer since he gets no credit whatever for higher power-factors which may be established.

In studying power-factor clauses of various companies it is found that the most general method of applying a penalty is by the use of what may be termed the proportional method, namely, that the demand upon which the consumer will be billed shall be the actual demand multiplied by what is considered a reasonable power-factor and divided by the actual power-factor, if the power-factor is below what is considered reasonable.

Since low power-factor necessitates additional capacity to carry the load of the consumer, a penalty for low power-factor is concerned primarily with the investment portion of the rate schedule and since practically all companies, at least for their larger loads, are now applying a demand-plus type of rate, the demand charge of which at least in theory is designed to protect the investment made to serve the consumer, the most logical method of taking account of power-factor in the rate schedule is by a correction in the maximum demand upon which the demand charge shall be based and the proportional method is the one suggested.

There is one other question which has not been touched upon, namely, a bonus or premium to the consumer who may maintain a power-factor in excess of what is considered reasonable. A great many companies do not consider that such a bonus or reduced rate should be allowed where the consumer operates in excess of a reasonable power-factor since in the first instance the rate schedule should be based on the assumption that all consumers will maintain a reasonable power-factor and further, since a correction in power-factor above 85 or 90% results in benefits which are relatively small.

The application of a penalty for low power-factor would not be made so much with the idea of increasing earnings as toward the end of having a method, by the enforcement of which there will be an incentive for the consumer to improve his power-factor.

RATE INCREASES IN OTTUMWA, IA., SUSTAINED BY COURT.

Following the repeal by the Ottumwa, Ia., city council of ordinances seeking to forbid increases in electric light, power and steam heat rates by the Ottumwa Railway & Light Co., a rate case in the federal courts, originating in 1918, has been dismissed by Federal Judge M. J. Wade, thus settling all litigation between the company and the city. The decision means that the increases in service rates in effect since 1917 are sustained.

OPERATING PRACTICE

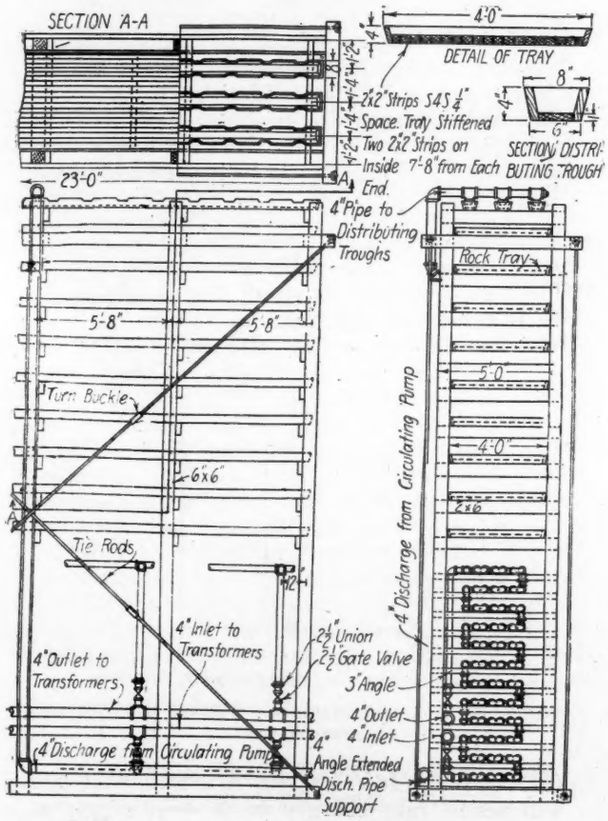
Methods and Problems Embracing Operation and Installation of Power-Plant Equipment and the Distribution of Electrical Energy

COOLING TOWER SERVES BANKS OF LARGE TRANSFORMERS.

Coils in the Bottom of Cooling Tower Carry the Transformer Cooling Water and Rock-Filled Trays Conserve Tower Water.

The Northern States Power Co., Minneapolis, Minn., is operating some large transformers for tieing in its high-tension transmission lines from St. Croix Falls, Wis., and Wisota, Minn. These transformers step down the voltage from 110,000 to 13,000 volts, there being three 15,000-kw. and three 7500-kw. units.

They are located away from water supply and supervision, and as they depend upon water cooling it has been necessary to erect a cooling tower



Details of Cooling Tower Used by Northern States Power Co.

that would on the one hand afford sufficient cooling surface and on the other hand would minimize loss of water by evaporation. The accompanying illustration shows the details of the tower as it is being used.

The tower is constructed of creosoted wood and is 24 ft. in height. There is a series of nine wooden trays measuring 4 by 9 ft. with a spacing between trays of 18 ins. Each tray is filled to a depth of 3 ins. with crushed rock. (It has been found that pebbles are preferable to crushed rock.) The water is piped to the top of the tower and then passes through three distribution troughs. The pipes at the bottom of the tower, which are used for radiation, consist of 1700 ft. of 2.5-in. iron pipe arranged in twelve layers, as shown.

There are two motor-driven pumps. The one pumps the water from a water-storage pit or sump through the transformer cooling coils, the coils of all transformers being in parallel so that any transformer may be taken out of service without interfering with any other set of cooling coils; the other pump sends the heated water to the top of the cooling tower. The transformer cooling-water pump is driven by a 10-hp. squirrel-cage induction motor, while the tower pump is driven by a 25-hp. variable-speed induction motor. The variable-speed motor is used so that its speed may be changed with changing load, thus reducing the water circulated over the tower and so cutting down the loss of water by evaporation and spray. The heat-dissipating ability of the water-storage reservoir is thus utilized during lighter loads and when outdoor temperatures permit. The cold-water sump is 6 ft. deep, 10 ft. wide and 10 ft. long. When operating normally, about 300 gallons of water per minute are circulated.

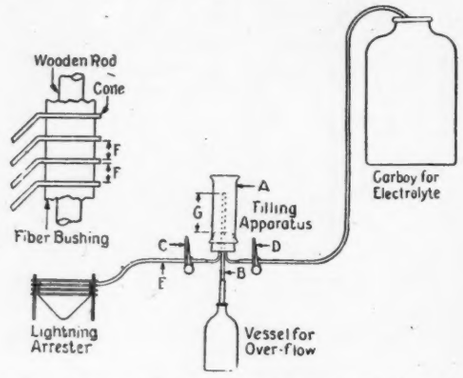
FILLING AND TESTING ALUMINUM-CELL ARRESTERS.

Only the Proper Electrolyte Should Be Used and Care Should Be Taken to Fill and Charge All Cells.

Lightning arresters are a vital part of every distribution system, and afford substantial protection against surges of voltage when maintained in good working condition. Arresters of the aluminum-cell type are in service on a large number of systems, and under a wide variety of operating conditions. Good ground connections, daily charging and periodic overhauling are essential to the maintenance of this type of equipment in effective working condition. Daily charging is a matter of operating routine, and good grounding depends upon a periodic examination of the original ground connection which it is assumed was installed correctly according to the manufacturer's instructions. Overhauling should be done at intervals of a year unless trouble develops, in which case the arrester should be examined and repaired at once.

The accompanying illustration shows a suitable equipment for refilling cells after an overhauling. It is a common practice for the manufacturer to

supply a cell filler similar to the one shown, but if the regular filler is not at hand one may be made from glass and rubber tubing without difficulty. The rubber and glass tubes and containers should be thoroughly cleaned to prevent any possible contamination with foreign materials of any kind. The stopper in the bottom of the filler tube *A* should be provided with three holes through which the connecting tubes are inserted. A rubber stopper is well suited for this purpose, and can be purchased with the desired holes already cut. By varying the distance *G* the filler



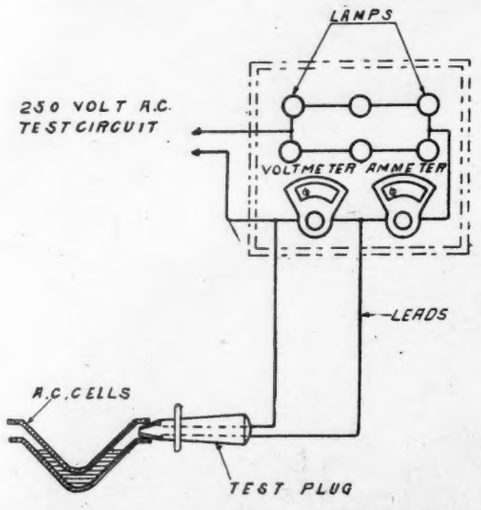
Equipment Convenient for Filling Aluminum-Cell Lightning Arrester.

tube *A* may be made to measure out the same amount of electrolyte for each cell, the proper amount depending upon the particular type of arrester.

Before starting to fill an arrester it should be definitely determined that the electrolyte being used is correct. The safe practice to follow in this matter is to use only the electrolyte supplied by the manufacturer. Cases have occurred where storage-battery electrolyte, that is sulphuric acid, has been put into lightning arresters to the very serious detriment or destruction of the arrester. Acids or any other foreign material should not be allowed to come in contact with the electrolyte or cells, and electrolyte should never be placed in an acid carboy. To start the filling operation the pinch cocks *C* and *D* are closed and the filler tube *A* is partly filled with eleetrolyte. The filler tube *A* is then raised up above the carboy and the cock *D* is opened allowing electrolyte to flow through and fill the rubber tube. When the tube is filled the cock *D* is closed and the filler tube *A* is lowered to its normal position as shown in the illustration. The cock *D* should now be opened again until the electrolyte rises in *A* and starts to overflow through the pipe *B*, when *D* should be closed and *C* should be opened to allow the charge of electrolyte to flow into the first cell. The rubber tube *E* should be inserted about 1.5 ins. into the cell at a point midway between the cone-stack support sticks. The cock *C* should now be closed, tube *E* should be inserted in the next cell, cock *D* should be opened allowing *A* to be refilled. When *A* is filled to the top of the overflow pipe the cock *D* is closed and *C* is opened, filling the second cell. This procedure is continued until all cells are filled, when the stack will be ready for a preliminary testing of the individual cells.

A convenient testing set suitable for the trying out of cells is shown in the accompanying illustration. The test plug serves to connect the two halves of the cell, one-half through each lead, to the instruments, lamp bank and test circuit. Sufficient number of lamps should be used and connected to limit the current to a maximum of 2 amperes when the plug terminals are short-circuited. Testing is started by inserting the plug between the two cones of the bottom cell as shown in the illustration. If the cell is filled properly there will be a slight spark at the instant of making contact, the ammeter will show a flow of current decreasing to 0.2 or 0.4 ampere and the voltmeter will come up to practically the full voltage of the circuit. It usually takes about 10 sec. to test and charge a cell in this manner, and caution should be taken not to leave the current on long enough to cause the cells to heat. Comparison of the voltages across the cells when charged, and with the current flowing, will indicate the relative condition of the films. Current values also serve to indicate both film condition and the area of the cell in service; if a cell has been double filled the final current will be approximately twice the normal value.

Each cell should be tallied in some way when filled and again when tested and charged in order to make sure that all are properly cared for. As a final check the test leads should be applied over the entire stack after the individual cells are all filled, tested and tallied. If there is no spark when making connection with one terminal each to the top and bottom cells, there are empty cells in the stack and they should be located and cared



Testing Equipment Suitable for Testing and Charging Arrester Cells.

for. If only 125-volt service is available the cells will not be fully charged in the testing process, and special precautions must be taken when putting the arrester in service. If 500-volt service is used the cells may be charged two at a time, and if only d-c. service is available the cells must be subjected to the testing operation twice. In the second test with a d-c supply the leads should be reversed so that a test and charge is applied in both directions. After testing with direct current the cone stack should always be discharged to ground before it is handled to avoid a possible shock.

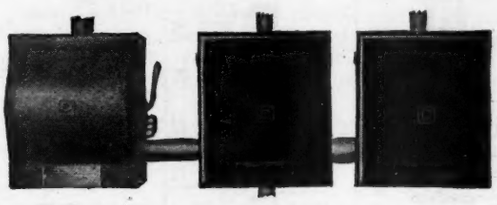
CONTRACTING-CONSTRUCTION

A Department Devoted to Various Problems Relating to the Installation, Operation and Maintenance of Electrical Equipment

SWITCH AND CUTOUT CABINETS OF IDENTICAL DESIGN.

Selection of Standardized Cabinets Reduces Office and Job Costs and Results in Better and More Satisfactory Work.

The uniformity of appearance of an otherwise good job of construction work is often destroyed by the assembling together of a varied assortment of cabinets for inclosing switches and cut-



Installation of Square D Cutout and Switch Cabinets of Similar Design.

outs. Aside from the poor appearance which this kind of work presents, such construction practice may also be quite wasteful of time. When a workman must handle boxes of different size and shape, and with outlets arranged in various ways, he must give both time and thought to the planning of the installation. However, if his materials are all of the same design so that he can interchange cutout and switch boxes at will, he will be able to lay out a complete and workmanlike job in the shortest possible time.

Much time and confusion will also be saved in the estimating of work and purchasing of equipment if uniform standard materials are available. Comparatively inexperienced office employees can order and check such supplies as are well standardized, and so relieve the more skilled help for other important work. The accompanying illustration shows how such uniform equipment may be assembled to present a pleasing appearance and at the same time make a good and substantial job. In this particular case an inclosed switch and two cutout cabinets are mounted together.

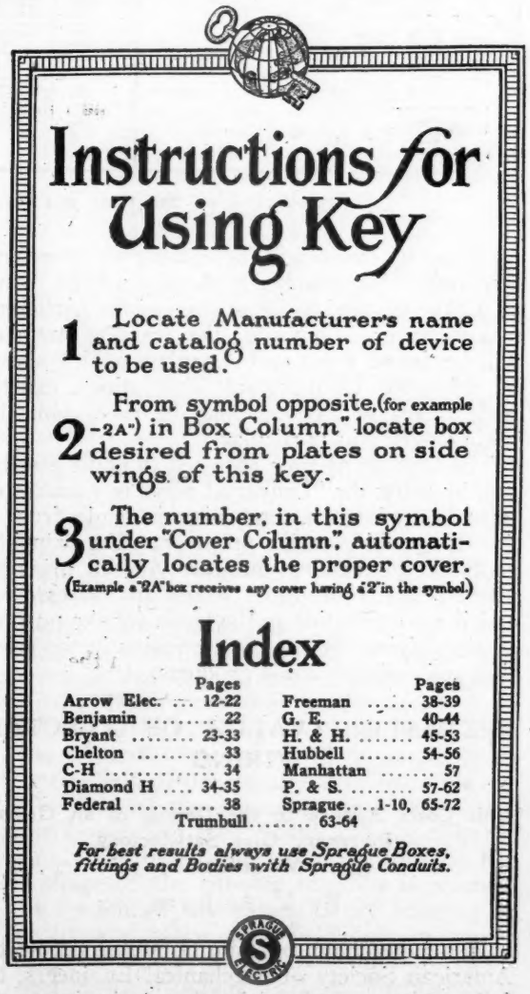
KEY FOR MATCHING WIRING DEVICES, BOXES AND COVERS.

Catalog Numbers of Wiring Devices of Various Manufacturers Are Tabulated Opposite Box and Cover Symbols in the Key.

It has been necessary in matching incomplete wiring devices and outlet boxes to search through the catalog of the manufacturer of a given device for the parts that were wanted. In time the devices sought for might be found, but in case any one of the devices was produced by another manufacturer it was necessary to make a search of a second catalog. Much valuable time has been lost in this way, and, in addition, no assurance was provided that the device would fit the box once it could be located in the catalog.

This searching for catalog numbers of wiring devices and uncertainty as to whether they will fit one another has been eliminated by a "Universal Key," prepared by the Sprague Electric Works of General Electric Co., New York City. It is in the form of a 70-page pamphlet, within which the tabular matter is arranged so that the work involved in matching wiring devices, boxes and covers is made easy, and the amount of time required to do the matching is greatly reduced. Moreover, the products of practically all of the principal manufacturers are included in the references, so that the pamphlet is universally applicable.

Having given the wiring device intended to be


Instructions for Using Key
1 Locate Manufacturer's name and catalog number of device to be used.
2 From symbol opposite, (for example "2A") in Box Column" locate box desired from plates on side wings of this key.
3 The number, in this symbol under "Cover Column", automatically locates the proper cover.
(Example a "2A" box receives any cover having a "2" in the symbol.)
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Arrow Elec. ... 12-22
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Hubbell 54-56
Manhattan 57
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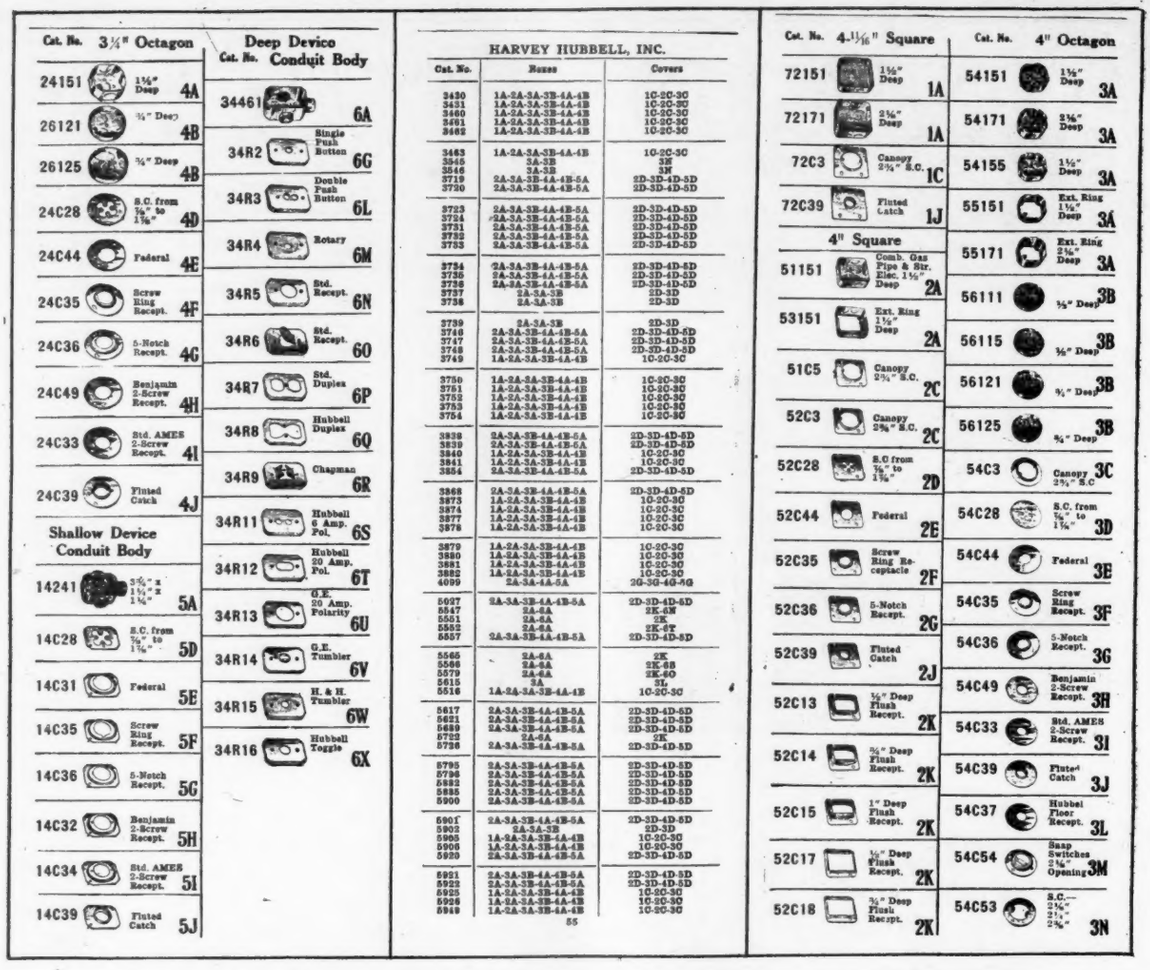
Sprague....1-10, 65-72
Trumbull..... 63-64
For best results always use Sprague Boxes, fittings and Bodies with Sprague Conduits.

Instruction Page, Giving Method of Selecting Wiring Devices That Fit Together.



Reproduction of One Page and Marginal Illustrations From "The Universal Key."

used and its number in the catalog of its maker, a corresponding number in the key will be found on a page devoted to the devices of the particular manufacturer. Opposite the catalog number will be found a group of symbols which show, by reference to marginal illustrations, exactly what boxes and covers may be used with the wiring device in particular.

The amount of time required to make a selection by using the "Universal Key" is a matter of seconds, and when a selection is made from it the items will combine properly. The pamphlet contains the catalog numbers of the principal manufacturers of outlet boxes and accessories, and is a contribution to the trade for the purpose of simplifying the present confusion in the selection and ordering these products.

ESTIMATING VALUE OF ELECTRIC WIRING.

Unit Costs Applied to the Details of an Orderly Inventory Give Satisfactory Valuations.

By L. A. Joyce.

In a paper given by John G. Morse before the American Society of Mechanical Engineers, the following was outlined by that authority as the desirable procedure in making appraisals of wiring in buildings for valuation and insurance purposes (Mr. Morse is appraiser for the Inspection Department of the Associated Factory Mutual Fire Insurance Companies):

Electric wiring should be divided into two main groups, one for lighting and the other for power. The number of light outlets in each room can usually be obtained from the local electrician. A factor per light is applied to those of each size. The horsepower of motors can be obtained from the inventory of machines. As it will cost more to wire several small motors than a single large one, which is equal in power to the others combined, they can be divided into two or more groups according to conditions. Then a factor is applied to each group. A percentage of this total amount of both light and power wiring should be added for cables at the power house or, in a case where energy is supplied from outside, at the transformer house. For electroplating wiring, a factor per sq. ft. of surface of plating tanks has been found accurate. For the wiring to electric-welding machines, where these are supplied from a central dynamo, a factor per machine can be used. In plants manufacturing electrical apparatus, a large amount of test wiring is found. Actual inventory of this can usually be rendered unnecessary by consulting with the electricians in charge, a lump-sum estimate being satisfactory as a rule.

QUESTIONS AND ANSWERS

All readers are invited to submit questions and answers to this department. Anonymous communications will not be considered. Questions should relate to electrical matters of any kind. Answers contributed by readers should be submitted preferably within eight days of the date of publication of the question and should be limited, if possible, to 300 words. Payment will be made for all answers published.

Questions.

No. 492.—Load-Factor on Distribution Transformers.—What is the customary ratio of maximum load to average load carried on distribution transformers serving purely residence neighborhoods when but few appliances are in use? What is the ratio when a considerable number of appliances are fairly well distributed among the customers? What is the ratio of total kw-hr. output of such transformers to their total kw-hr. capacity when working at their maximum demand? What transformer capacity should be installed per kilowatt of total connected load for purely lighting load and for a load involving the use of appliances as well as lighting?—R. H. C., Woodland, Ill.

No. 494.—Operating 60-Cycle Motor on 50 Cycles.—I have a 220-volt, 1200-r.p.m., 60-cycle induction motor which I want to install on a circuit operating at 220 volts and 50 cycles. The machine is in good order and is free from grounds, having been tested out with a pressure of 750 volts between winding and core. It operates without any unusual sound and without heating at no load, but I am not certain just what would take place if the machine was put under load which will be about 7.5 hp. for a period of 10 hrs. per day. Should the motor be rewound or will it operate safely at 7.5 hp.?—H. F. W., Logansport, Ind.

No. 495.—Synchronous Motor as a Condenser.—Will someone please explain for me just how it is that a synchronous motor acts like a condenser? I have read any number of articles on the use of motors as condensers, but have never had a clear explanation given as to how such an effect is produced.—R. H. N., Peoria, Ill.

No. 496.—Meter for Rectified Current.—What kind or type of ammeter should be used to measure accurately the current delivered on the d-c. side of a mercury-arc rectifier?—H. R. G., Houston, Tex.

No. 497.—Use of Reactors on Transmission Lines.—What are the factors which govern the size of a reactor that should be installed on a transmission cable to give protection from grounds? Do reactors that are suitable for protection against short-circuits give the same degree of protection against grounds? Are reactors essential or useful on well constructed overhead lines? Can overload relays be safely eliminated on lines that are properly protected by reactors?—A. B. R., Peoria, Ill.

Answers.

No. 498.—Motor-Operated Centrifugal Pump.—I have recently re-installed a motor-driven centrifugal pump and have had a considerable amount of trouble in trying to make it operate. This pump is driven by a three-phase 5-hp. induction motor having a synchronous speed of 1200 r.p.m. The pump, as originally installed, delivered water from a tank at about the same elevation as the pump suction to another tank located 25 ft. above. As now installed, the pump has to raise the water only about 7.5 ft., but continually blows the fuses and heats up badly. The motor is not grounded or short-circuited and the pump seems to be in good order. I have increased the suction and discharge lines from 2-in. to 3-in. pipe without relieving the trouble. What can be the cause of the difficulty?—B. R. D., Atlanta, Ga.

Answer.—The trouble experienced is probably due to the fact that the pump, which formerly operated against a static head of 25 ft., is now raising the water only to a height of 7.5 ft. It is a peculiarity of the centrifugal pump, if not designed particularly to take care of such conditions, to discharge an excessive quantity at low efficiency when operated at a head much below that for which it was designed. This condition may cause a serious overload. In this particular case the change from 2-in. to 3-in. pipe, instead of relieving the trouble, only serves to make conditions worse. If there is a valve in the discharge pipe, temporary relief can be obtained by partly closing this valve to increase the discharge pressure of the pump to that at which it formerly operated. The pump should be replaced by one designed for the present situation.—R. L. D., Minneapolis, Minn.

Answer.—Since the total head against which the pump must operate has been reduced from 25 to 7.5 ft., the motor running at the same speed causes a much greater volume of water to be discharged. The pump efficiency is lower than normal under such conditions, and the motor is overloaded. Either the speed of the motor must be reduced, or a valve must be put in the discharge pipe. With a valve in the discharge line the head may be increased to 25 ft. by partially closing the valve, and the pump will operate as in the original installation.—C. H. C., St. Louis.

No. 491.—Paralelling Belted Exciters.—Considerable difficulty is experienced in paralleling the exciters in the plant where I operate. There are two 150-kw. alternators direct-connected to Corliss engines in this plant. There is a 20-kw. exciter belted to each engine. These exciters carry a small amount of d-c. load during the day aside from serving as exciters. Our practice in paralleling is as follows: With one machine running and connected to the system, the second machine is brought up to proper speed as indicated by the synchronizing lamps. The incoming exciter is then brought up to voltage a little above the exciter-bus voltage and then connected. The second alternator is brought up to proper voltage a little above the main bus and cut into service.

In the period just before connecting in the second alternator, the two exciters sometimes give trouble. They will shift the load from one to the other, sometimes slowly and sometimes quite rapidly. Will someone tell me what the cause of this is and how this condition can be overcome? These alternators have to be paralleled every day and the exciter trouble is quite annoying.—J. C. B., Cincinnati.

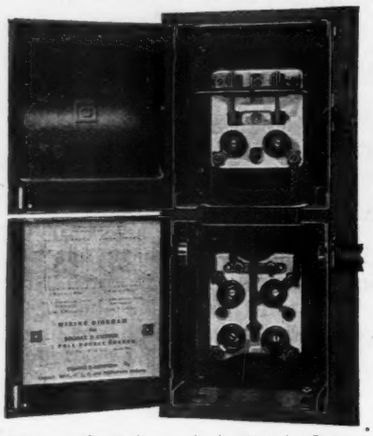
Answer.—The question does not state whether the exciters have a series field winding or, assuming that they have series field windings, whether there is an equalizer connection. Compound-wound exciters which are to be run in parallel should always have the switching so arranged that the equalizer connection is made first. Then, by closing the line switch connected to the series winding of the incoming machine, its series field is connected in parallel with the series field of the running machine, thus exciting the field of the incoming machine. The shunt field switch is then closed and the voltage built up. The other line switch is closed when the voltage of the running machine is reached. If the machines are paralleled by building up the voltage with the shunt field only and then closing in with no current flowing in the series winding of the incoming machine, fluctuations in the load will always be experienced.—H. S. R., Wahpeton, N. D.

NEW APPLIANCES

Newly Developed and Improved Electrical and Mechanical Apparatus, Appliances, and Devices Now Being Placed on the Market

Cutout Cabinet of Same Design as Entrance Switch.

To provide a more economical method of installing cutouts with their switches,



Entrance Switch and Inclosed Cutout Connected by Special End Plate.

the Square D Co., Detroit, Mich., has designed and placed on the market a standardized inclosed cutout. The inclosing box is so designed and built as to harmonize with the manufacturer's switch cabinets, thus providing for a uniform and workmanlike job when both equipments are mounted together.

The double-branch cutout is arranged for two-wire distribution from either two or three-wire service. The box is equipped with a latch so that it may be locked or sealed shut, and is provided with knockouts so that distributing circuits may be carried out in the most convenient manner. The cutout box can be attached to the top or bottom of Square D safety switches by a special connecting end plate. As the box is made with both ends open, a standard Class A end plate is always required in addition to the special connecting plate.

Heavy-Duty Terminal Clip.

Connection clips in various sizes are useful on the testing floor, in the laboratory, in meter testing and in a variety of places where temporary supervised connections are required. The Mueller Electric Co., Cleveland, has developed and placed on the market a clip for meeting such service where fairly large values of current are to be handled. This clip, which is shown in the accompany illustration, is rated at 200 amperes, but, according to the manufacturer's statement, will carry much larger currents for short periods of time without undue heating.

A copper alloy of proper stiffness is used for the main clip body, and a stiff spring assures plenty of pressure to give a firm grip. Flanges at the sides of the clip body add to its stiffness, and a copper shunt at the hinge prevents heating either at that point or in the spring, where excessive heat might result in the weakening of the grip. The jaws, which have a 2-in. spread, are not provided with teeth, but have a slotted lip for holding fast to a stud or nut.

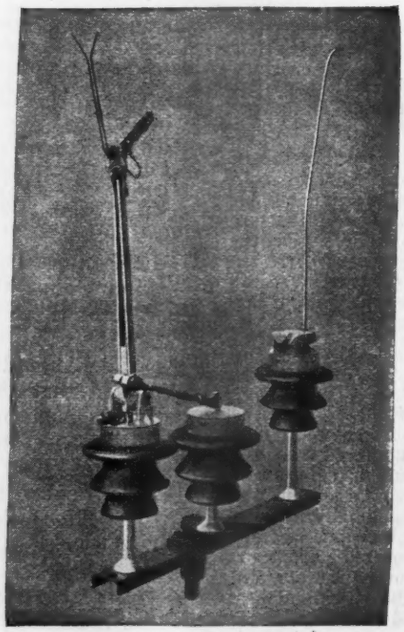
It is suggested by the manufacturer that these clips are suitable for use in arc burning and in work around a bat-

Terminal Clip Suitable for Use in Circuits Carrying Up to 200 Amperes.

tery room, when lead coated, in addition to the uses generally made of such clips.

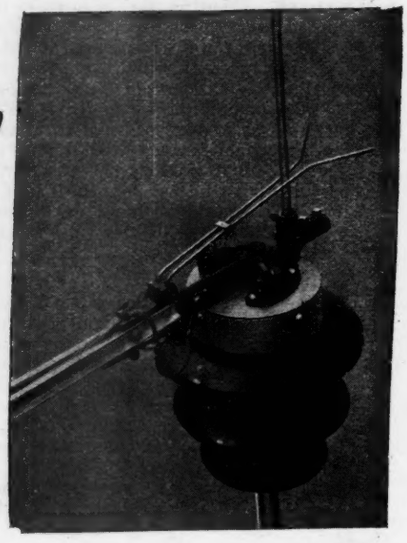
Air-Break Switch.

An increasing use of the outdoor substation and the extension of distribution lines into rural districts has caused a large demand for air-break switches of considerable voltage capacity. To meet this demand the Hi-Voltage Equipment Co., Cleveland, has produced a line of switches embodying a number of novel features. The switch arm or blade is mounted on one of the end insulators, and is operated through a link mechanism actuated by movement of the center



Hi-Voltage Switch in the Open Position.

insulator. The construction is such that the arc formed on opening the switch is raised or lifted up the horns with the movement of the switch blade. The illustration shows one of the switches in the open position, with the tips of the arcing horns high above the fixed contact. The second illustration shows the switch blade in the closed position,



Fixed-Contact End of a Hi-Voltage Switch Showing Contacts and Terminal.

with the forked horns of the blade crossing the long vertical horn of the fixed contact. This illustration also shows the blade contact straightened out and in position between the flexible clips of the fixed contact terminal. The lug and set-screws for receiving the line conductor are also plainly shown. All live iron or steel parts of the switch are galvanized and the construction is weather proof, protection against ice and sleet being provided where required. The construction is designed to prevent water from working into the main bearing which is babbitted and provided with a grease reservoir for lubrication. A sleet hood covers the main contact to provide definite protection for this vital part of the mechanism. Each of the four contacts, which have a current capacity of 100 amperes, is mounted on a separate self-aligning spring support.

Two 1-in. steel channels are used to form the structure of the main switch arm. The insulators are locked to the forged-steel pins by a special spring clip which effectively prevents the accidental movement of the insulator, but allows for its easy removal. All of the insulators are interchangeable, so that a single spare unit may be made to serve in case of the failure of any one of the three units. The general design of the entire equipment is such that any defective part may be replaced without removing the entire switch from the pole. Duplicate single-pole switches are interconnected for a two or three-pole switch, and are operated by a single handle.

ACTIVITIES IN THE TRADE

Business Developments, Sales Agencies, Trade Literature and Miscellaneous Items Concerning Electrical Manufacturers and Allied Business Interests

S F. Bowser & Co., Inc., Fort Wayne, Ind., held its annual sales convention, June 28-July 2, with the largest attendance of salesmen in the history of the company.

Jackson Electric Motor Repairing Co., Bellevue avenue, Trenton, N. J., will build a one-story plant, 42 by 100 ft. on Belvidere street. Considerable equipment will be installed in the plant.

Branch Electric Lamp Co., 173 Mercer street, Jersey City, N. J., has filed notice of organization to manufacture electric lamps and other electrical products. Emanuel D. Bach heads the company.

Steel City Electric Co., 1207 Columbus avenue, Pittsburgh, has awarded a contract for the erection of a two-story addition, 48 by 55 ft., to its present works, used for the manufacture of electrical equipment.

William A. Donmayer announces his removal from 1242 Walnut street, Allentown, Pa., to 730 Walnut street, where he will open a store for the sale of electrical supplies and also conduct a business as a general electrical contractor.

Griscom-Russell Co., 90 West street, New York City, is sending the trade bulletin No. 1111, in which is described the "Stratton" air separator, used for the removal of water from compressed air. Illustrations and tables of data of the work of the separator are given in the bulletin.

Re Qua Electrical Supply Co., Inc., 95 St. Paul street, Rochester, N. Y., jobbers of electrical supplies, handling "everything electrical," devotes its efforts entirely to the jobbing end of the industry and are not in the manufacturing line as was inadvertently stated in a recent issue of the ELECTRICAL REVIEW.

Benjamin Electric Manufacturing Co., Chicago, is sending a letter and leaflet to the trade calling attention to the 20-ampere heavy-duty receptacle with cap manufactured by the company, designed primarily for use with 32-volt farm-lighting circuits. A full description of the receptacle is given together with an outline of the advantages claimed for it by the company in connection with its use on portable electric devices.

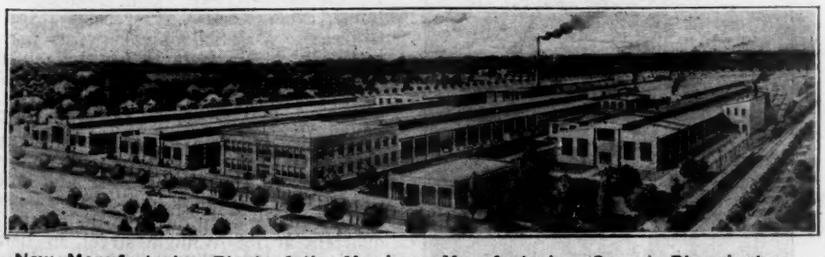
C. S. Bigsby Co., 190 Boylston street, Boston, distributor of the New Premier electric vacuum cleaner, has established a branch office at 27 Eddy street, Providence, R. I. C. C. Bruler is in charge of the Providence branch.

Hartwig Advertising Co., Inc., Wainwright buidling, St. Louis, recently incorporated and taking over the business of the Hartwig Advertising Co., has increased its office room to make space for its art and research departments, recently established. The company will specialize in technical advertising.

Westinghouse Lamp Co., 165 Broadway, New York City, is having plans prepared for the construction of a plant to be located at Indianapolis, Ind. The new works will be similar to the company's plant at Trenton, N. J., and will be used for incandescent lamp manufacture. It is proposed to have a capacity in excess of 55,000 lamps daily. The project, with equipment, is estimated to cost over $2,000,000.

Delco Light Co., Dayton, O., is sending to the trade four booklets describing in detail the isolated electric light and power service appliances manufactured by the company. The appliances described are the standard 0.75-kw. plant of the company which has been on the market for several years, and the 0.5-kw., 1-kw. and 3-kw. which are designed for service where the standard size is too small or too large.

Meadows Manufacturing Co., Bloomington, Ill., dedicated its new factory building July 6, with appropriate ceremonies, including one unique feature in that the dedication speech was made in the nature of a prayer by Rev. I. W. Longenbaugh, it being believed that this is the first time a factory building has been so dedicated. John Rocke, president and general manager of the company, traced the development of its business from a small beginning in the manufacture of grain elevators to the present time, when besides elevators, washing machines and many other articles are manufactured. The new building is modern in every respect and gives the company greatly increased manufacturing facilities over those that prevailed at the former plant of the company at Pontiac, Ill.



New Manufacturing Plant of the Meadows Manufacturing Co. at Bloomington, Ill., Dedicated July 6, 1920.

National Specialties Co., Lightner building, Detroit, dealers in lamps and fuses, has established a branch office in the Marion building, 1243 Third avenue, Cleveland.

Gross & Gross, 25 South Orange avenue, Newark, N. J., have filed notice of organization to operate as electrical contractors. Samuel Gross is the head of the company.

Rickard & Sloan, Inc., New York City, advertising specialists, are now located at 25 Spruce street, the increasing business of the firm making the change in quarters a necessity. The new offices are well equipped for handling the business of the firm and are within easy reaching distance of every rapid transit line in New York City.

Cutler-Hammer Manufacturing Co., Milwaukee, has issued a two-color booklet describing the new line of elevator control apparatus recently developed by the company. The booklet, known as publication No. 840, illustrates the new controllers and emphasizes the simplicity, quiet operation and smooth acceleration claimed for them by the company.

American Ever Ready Works of National Carbon Co., Long Island City, N. Y., now has in progress a $100,000 advertising campaign for "Eveready" tungsten batteries that is designed "to put flashlights back on the job." During the campaign which is now at its height, close co-operation with dealers is provided by listing 50,000 of them in newspaper advertisements in 282 cities, thus giving the public the names of dealers who carry fresh batteries. Window decorations, motion-picture theater slides and electrotypes and matrices for newspaper advertisements, are also furnished the dealers, so that window displays and local advertising can tie up with the national campaign.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has issued a circular entitled, "Marine Equipment in the Fabricated Ship," which describes and illustrates geared-turbine machinery for the 9000 dead-weight ton cargo boats built by the Merchant Shipbuilding Corp., Bristol, Pa. The history leading up to the development of the fabricated ship is outlined and the method of fabrication is described. A general description of this type of vessel built by the corporation is given together with some of the more important dimensions. In addition, plan and vertical drawings of the ship are reproduced, the details of the propelling equipment being shown. Photographs and line drawings indicate the type of turbines used for these ships. Typical photographs show the operating platform and views of the engine room. Photographs of the shipyard of this corporation and typical ship views are also shown.

PERSONAL MENTION

Biographical Sketches and Chronicle of Changes in Business Connections, Promotions and Other Personal News of the Industry

H. A. PTOLOMY has been appointed assistant fire and safety inspector of the Public Service Co. of Northern Illinois, with headquarters at the Chicago office.

ROBERT M. EAMES, of the Bryant Electric Co., Bridgeport, Conn., was elected president of the Bridgeport Export Managers' Club, recently organized.

CLOYD M. CHAPMAN has resigned from the organization of Dwight P. Robison & Co., New York City, to take up a private practice as a consulting engineer.

J. F. OWENS, general manager of the Oklahoma Gas & Electric Co., has been elected vice-president of the Oklahome City (Okla.) Chamber of Commerce.

CLARK KEITH, Windsor, Ont., has been appointed assistant chief engineer of the Essex Border Utilities Commission, with jurisdiction in several municipalities on and near the Detroit river.

P. C. FORDYCE has been appointed superintendent of power for the West Penn Power Co. at Waynesburg, Pa., succeeding W. T. McCormick, who has been transferred to the securities sales department.

W. M. STEPHENS has been appointed chief engineer in charge of operation and maintenance of the new Colfax power station of the Cheswick Power Co., Pittsburgh. Mr. Stephens was formerly chief engineer at the Brunots Island station of the company.

J. M. GRAVES has been made assistant general manager of the Duquesne Light Co., Pittsburgh. Mr. Graves, who was formerly superintendent of power stations for the company, is a graduate of the University of Kentucky, and has been connected with the Duquesne company and its subsidiaries since 1902.

C. M. MASSON, who designed the illumination of the grounds of the Huntington Hotel, at Pasadena, Cal., during the National Electric Light Association convention, is the illuminating engineer of the Southern California Edison Co. He was born at Hammondsport, N. Y., in 1876, and upon his graduation from Lehigh University as a mechanical engineer did three years' special apprentice work with the Westinghouse Electric & Manufacturing Co. In 1903 Mr. Masson went to California to become associated with his cousin, R. S. Masson, then consulting engineer for all the Huntington properties in southern California. Returning to the East in 1910, he took a position as electrolysis engineer with the Pennsylvania Railroad in its electrified zone around New York City, but relinquished that to return to California in 1912 and join the forces of the Southern California Edison Co. as illuminating engineer. His work in the illumination of the Hotel Huntington grounds called forth much praise from the convention delegates and visitors.

J. HOWARD WHEATLEY has been made sales engineer of the Blashill Wire Machinery Co., Ltd., Montreal, Que.

D. C. GREEN, general manager of the Fort Smith Light & Traction Co., has been elected president of the Business Men's Club, Fort Smith, Ark.

CLIFFORD S. MACCALLA has been appointed vice-president and general manager of the Virginia Power Co., Charleston, W. Va.

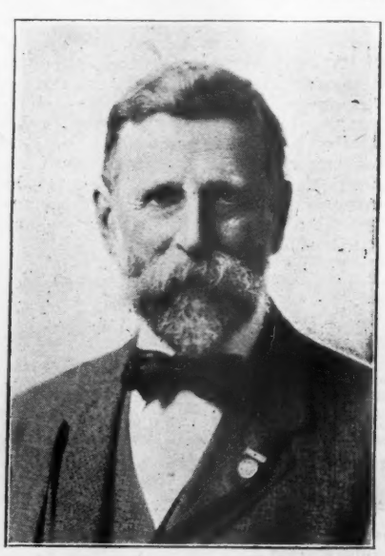
R. E. HANNA has been appointed assistant treasurer of the Philadelphia Co., Pittsburgh. Mr. Hanna has been connected with the treasury department of the company since 1901.

EDWIN GRUHL has been appointed a vice-president of the North American Co. He has been assistant to the president of the company since 1912 and is also vice-president of the Wisconsin Edison Co., and president of the Wells Power Co.

EDWARD N. HURLEY, president of the Hurley Machine Co., Chicago, and ex-chairman of the United States Shipping Board, has been added to the board of directors of the American Manufacturers' Foreign Credit Underwriters, incorporated last year to organize and operate an American manufacturers' exchange for the safeguarding of foreign trade.

OBITUARY.

ISHAM RANDOLPH, widely known as a civil engineer, died at his home in Chicago, Aug. 2, of bronchial pneumonia. He was 72 years old. It was as chief engineer of the Chicago drainage canal, the building of which he directed, that Mr. Randolph attained his greatest fame, though he was at one time considered for the leadership in the completion of the Panama canal. Mr. Randolph was born in Chapel Hill, Va., in 1848, and, to use a term of his own, "broke into the engineering ranks with an ax nearly 50 years ago." The outbreak of the Civil war blasted the fortunes of his family and he was forced to forego a technical education. His first position was with the Winchester & Strasburg Railroad in Virginia, doing the humblest and hardest sort of work with the engineers and surveyors. There he remained until 1872 when he entered the service of the Baltimore & Ohio Railroad, making surveys of the Chicago extension of that line. In 1880 he came to Chicago as chief engineer of the Chicago & Western Indiana Railroad and after important work for it and other railroads established himself in Chicago as a civil engineer in general practice in 1898. When it was decided to build the Chicago drainage canal he was the fifth man chosen for chief engineer. When he entered on the work, June 7, 1893, only about 5% of the project had been completed. It was Mr. Randolph who, on the night of Jan. 17, 1900, led a party to Lockport, Ill., and let the water through into the canal from Lake Michigan for the first time to head off an injunction which he had learned was to be asked of the United States Supreme Court at Washington the next day by the authorities of the city of St. Louis. In 1903 as the canal was nearing completion he became involved with Lyman E. Cooley, first engineer of the canal, in a controversy regarding mechanical problems presented. The controversy attracted nation-wide attention, but Mr. Randolph was able to demonstrate the correctness of his theories and the canal was completed successfully. He resigned as chief engineer of the Sanitary District in 1907. From 1905 to 1906 he was a member of the international board of consulting engineers of the Panama Canal Commission. Among other important works in which Mr. Randolph figured was the building of the obelisk dam above the Horseshoe Falls in the Niagara river. The dam designed by him revolutionized dam construction in this country, being built upright and later tipped over into the stream. Mr. Randolph was a member of many civic and engineering bodies and was active in his profession in many national and civic projects.



Isham Randolph.

ADRIAN ONDERDONK SCHOONMAKER, president and treasurer of the A. O. Schoonmaker Co., died at his home, New York City, recently, aged 69 years. Mr. Schoonmaker was born in Brooklyn, N. Y., in 1851 and received his education in the Wilson street school of that city and at the Brooklyn Collegiate and Polytechnic Institute. He began his business career as a drug clerk, but soon left that to take up his life work of the manufacture and sale of mica. So rapidly did the business expand that it soon outgrew the original quarters at 158 William street, in 1902 moving to 221 Fulton street, and in 1912 to 88 Park place, the present place of business.

BUSINESS OPPORTUNITIES

News of Electrical Construction Projects in All Parts of the Country, Proposals Invited, Foreign Trade Openings and New Companies

EASTERN STATES.

Brunswick, Me.—The board of directors of Bowdoin College, has arranged for the erection of an electric lighting plant at the institution, to cost about $25,000.

Woodstock, Vt.—The Maplewood Lumber Co., is planning for the erection of an addition to its power house.

Northampton, Mass.—The Nonotuck Silk Co. has completed plans for the erection of a new transformer station at its mills.

New Haven, Conn.—A portion of the Shore Electric Railway, which has not been in operation since last July, has been sold to the United States Rail & Equipment Co., and will be scrapped.

Batavia, N. Y.—The Genesee Light & Power Co. has received permission from the State Public Service Commission to issue stock for $56,700, the proceeds to be used for new construction and equipment at its power plant, and for improvements in its distributing system.

Buffalo, N. Y.—The Standard Oil Co., 1103 Elk street, has awarded a contract to the John W. Cowper Co., Fidelity building, the erection of a two-story power house at its local works, 52 by 200 ft., to cost about $160,000, including equipment.

De Ruyter, N. Y.—The village trustees have made application to the State Public Service Commission for authority to construct and operate a municipal electric power plant. The project was approved at a recent local election. J. H. Schaffer is the president of the village board.

Freeport, N. Y.—The village trustees are planning for extensions and improvements in the electric light system, to cost about $63,000.

Hinckley, N. Y.—The Oswego Falls Pulp & Paper Co., Fulton, N. Y., is planning the erection of a power house here, to be used for general mill service.

Malone, N. Y.—The Malone Light & Power Co. has been granted permission by the State Public Service Commission to issue bonds for $100,000, the proceeds to be used for extensions in electric power plants and improvements in system.

Manlius, N. Y.—Willard J. Phillips has made application to the State Public Service Commission for permission to build an addition to his local electric power system.

New York, N. Y.—James A. Hearn & Son, Inc., 20 West 14th street, has awarded a contract to the R. W. Howes Construction Co., 105 West 40th street, for the erection of a power house. The plant will be two-story, located at 26 West 13th street, and is estimated to cost $200,000 with equipment.

New York, N. Y.—The Submarine Wireless Co. is being dissolved and affairs of the company liquidated. The company is arranging to dispose of a number of its patents. Philip E. Donlin, Room 2006, 5 Nassau street, is in charge of the liquidation.

New York, N. Y.—The International Bell Telephone Co., Ltd., has filed notice of dissolution under New York state laws.

New York, N. Y.—The various sectional business men's associations in the uptown district, including the Fifth Avenue Association, Thirty-fourth Street Board of Trade, Sixth Avenue Association, and others, have perfected plans for the installation of improved street-lighting systems on important thoroughfares in this district. Double ornamental lighting fixtures, aggregating about 200 watts each, will be placed on 34th street, from Park avenue to Seventh avenue. A similar installation will be made at an early date on Seventh avenue, between 32nd and 42nd streets; on 42nd street, from Seventh avenue to Park avenue; and on Park avenue, between 34th and 42nd streets. Additional single lamps, each about 100 watts, will be installed on 31st, 32nd and 33rd streets, between Sixth and Seventh avenues. It is expected to have the entire system in operation at an early date.

New York, N. Y.—The New York Edison Co., Irving Place and 15th streets, has filed plans for the erection of a two-story substation and transformer house on Cedar street, 75 by 100 ft., to cost about $150,000.

Syracuse, N. Y.—The Jones Oil Engine Co., 227 Walton street, is having plans prepared for the erection of a power plant on Free street, 90 by 260 ft., to cost about $60,000.

Syracuse, N. Y.—The Marquise Telephone & Telegraph Co. has filed notice of an increase in its capital stock from $100,000 to $200,000.

Ulster, N. Y.—Charles P. Dickinson, Ellenville, N. Y., and associates, are planning the erection of an electric plant, for light and power service at Ulster and vicinity. It is also proposed to build an extension to the present plant at Rosendale, Ulster county.

Walden, N. Y.—The Wallkill Valley Electric Light & Power Co. has been granted permission by the State Public Service Commission for the construction of a transmission line from Walden to the Wallkill boundary line.

Camden, N. J.—The Victor Talking Machine Co. has completed plans and will take bids at once for the erection of an addition to its power plant. Ballinger & Perrot, 17th and Arch streets, Philadelphia, are the architects on the project.

Cape May, N. J.—The city commissioners have authorized the preparation of an ordinance to cover the establishment of a municipal electric light and power plant.

Dover, N. J.—The board of water commissioners has closed an agreement with the New Jersey Gas & Electric Co. for the installation of new electrical pumping machinery at the local waterworks.

Lakewood, N. J.—The Lakewood & Coast Electric Co. has been granted permission by the State Board of Public Utility Commissioners to issue stock and mortgage certificates aggregating $100,000, the proceeds to be used for extensions and improvements in its electric plant and system.

Perth Amboy, N. J.—The board of aldermen is planning for extensions and improvements in the fire and police alarm systems in different parts of the city. Jay B. Franke, city electrician, is in charge of the work.

Trenton, N. J.—The Utility Valuation Commission authorized by the state legislature at its recent session, composed of State Comptroller Bugbee and State Treasurer Read, is arranging for the appointment of engineers to carry out proposed plans for valuation of the system of the Public Service Railway Co. and other traction lines in the state. An appropriation of $100,000 has been provided for the work.

Harrisburg, Pa.—The Cumberland Valley Telephone Co. is arranging for a discontinuance of free service at Hanover, Spring Grove, New Oxford and other points in York County. The Fishing Creek Telephone Co. has arranged for the discontinuance of such class of service between Yocumtown and various parts of upper York county.

Mauch Chunk, Pa.—The Bell Telephone Co. has construction work under way on two new lines between here and Slatington, replacing lighter equipment now in service.

New Bloomfield, Pa.—The Perry County Telephone & Telegraph Co. is arranging for a stock issue to be used for extensions and betterments in its system.

North Philadelphia, Pa.—The Penn Iron & Coal Co. will erect a power plant at an estimated cost of $500,000.

Palmerton, Pa.—The State Public Service Commission has granted the Palmerton Lighting Co. permission to issue stock for $70,000, the proceeds to be used in plant extensions and system betterments.

Philadelphia, Pa.—Hafleigh & Co., American and Cambria streets, have filed plans for the erection of a boiler plant at their fertilizer works.

Philadelphia, Pa.—Lit Brothers, Market street, are taking bids for the erection of a power house, 76 by 80 ft., to comprise boiler and engine de-

partments. The structure will be located at 719 Filbert street.

Philadelphia, Pa.—The Lykens Valley Light & Power Co. has received permission from the State Public Service Commission for a bond issue of $37,000, for proposed extensions, etc.

Philadelphia, Pa.—The Philadelphia Rapid Transit Co. has received permission from the State Public Service Commission to issue bonds for $1,291,000 and $31,000, the proceeds to be used for extensions and betterments.

Philadelphia, Pa.—Plans have been filed by H. O. Wilbur & Sons, Inc., for the erection of a power plant at its chocolate works, North Second and Third streets, to cost about $175,000. The plant will be used for general works service.

Philadelphia, Pa.—The Sacred Heart Convent, Mascher street, has awarded a contract to T. Reilly, 1616 Thompson street, for the erection of a one-story addition to the power house at the institution, to cost about $25,000. Improvements will also be made in the present plant.

Waynesboro, Pa.—The Waynesboro Ice Cold Storage Co. is planning for an increase in its capital from $25,000 to $100,000 for expansion purposes, including plant enlargement with additional electrical and mechanical equipment.

Baltimore, Md.—The Maryland Casualty Co. has filed plans for the erection of a power plant at 40th street and Cedar avenue, to be used in connection with a large printing and administration project at this point, estimated to cost about $2,000,000.

Frederick, Md.—The board of aldermen has authorized an estimate of cost for the installation of a "white way" street-lighting system in certain sections of the city, and for improvements in the local electric power plant, including the installation of a new electric generator for increased capacity. It is proposed to secure power from the Hagerstown & Frederick Railway Co. at high voltage, and reduce to commercial voltage for local distribution. The work is estimated to cost about $500,000.

Inwood, W. Va.—H. C. Musselman, Biglerville, Pa., is planning the erection of an electric power plant here for local industrial service.

Albemarle, N. C.—The Southern Power Co., Charlotte, N. C., is planning the rebuilding of its power plant here recently destroyed by fire.

Prosperity, S. C.—The town council is planning the installation of a new electric street-lighting system. J. B. T. Scott is the city clerk of Prosperity.

Columbus, Ga.—The city council has arranged for the construction of a "white way" street-lighting system, to cost about $22,000.

Homestead, Fla.—The city has voted $15,000 in bonds for the purpose of installing an electric light and water system.

NORTH CENTRAL STATES

Cincinnati, O.—The Shott Manufacturing Co., manufacturers of wire, has been authorized to increase its capital stock from $60,000 to $100,000.

Cleveland, O.—The Cleveland Electric Illuminating Co. will build a two-story, 36 by 49 ft. substation addition at 1753 East 17th street.

Coshocton, O.—The Northern Ohio Traction Co. is having plans prepared for a new power house to be erected at Coshocton.

Springfield, O.—The Hoppes Manufacturing Co., manufacturer of heater and steam specialties, plans the erection of an extension to its plant.

Youngstown, O.—The Electric Steel Alloy Co. has developed plans for increasing the steel-making capacity of its Charleroi, Pa. plant from 10,000 to 25,000 tons yearly. Among the improvements planned are the installation of two electric furnaces, making three electric furnaces now in use by the company.

Macy, Ind.—The Fulton Telephone Co. has increased its capital stock from $5000 to $15,000.

Flint, Mich.—The Champion Ignition Co. plans a power house, estimated to cost $60,000.

Lawton, Mich.—The J. Hungerford Smith Co. will build a new power plant.

Manistee, Mich.—The Consumers Power Co. will erect a new transformer station at Junction dam, at an estimated cost of $50,000.

Petoskey, Mich.—Engineers have been engaged by the city to make a survey of the electric light system with a view of increasing the amount of power generated. For further information address M. J. Quinn, city manager.

Sunfield, Mich.—The town is planning the installation of an electric light plant. W. Miller is in charge of the project.

Wayne, Mich.—The village plans to install a 1,000,000 gals. per day motor-driven centrifugal pump in connection with a filtration plant soon to be opened.

Breese, Ill.—The city plans to construct a 2200-volt, three-phase, a-c. power line, from Breese to Ariston, including transformer stations, poles, etc. Fuller & Beard, Chemical building, St. Louis, are the engineers on the project.

Chicago, Ill.—Felt & Tarrant will build a seven-story factory addition and power plant at an estimated cost of $1,000,000.

Princeton, Ill.—The city will purchase a new unit for its lighting plant, which will develop 400 hp., $17,000 having been appropriated for the improvement.

Rockton, Ill.—Plans have been prepared for a new electric light system for the city streets.

Roscoe, Ill.—The city is planning the establishment of an electric light and power plant.

Springfield, Ill.—Montgomery Ward & Co., Chicago, will build a power house at its local plant, estimated to cost $20,000.

Fond du Lac, Wis.—The Eastern Wisconsin Electric Co. will make improvements in its power plant, costing about $1,250,000. H. R. Ellis is the general manager of the company.

Hartford, Wis.—Bids are being taken for a chain and pocket type coal elevator to be installed at the city lighting and power plant. William Radke is the city clerk of Hartford.

Milwaukee, Wis.—The General Welding Manufacturing Co., 347 Florida street, is building a one-story, 40 by 50 ft. brick and concrete addition to be equiped as a power house. The improvement will cost about $20,000.

Neillsville, Wis.—The Duplex Storage Battery Co. is concluding negotiations to remove its factory from Milwaukee to this city. The capital stock has been increased from $60,000 to $250,000 to finance the construction and equipment of a new plant. A. G. Shedden, Neillsville, has been elected secretary and treasurer of the company.

Austin, Minn.—The Austin Electric Co. will build a transmission line to King and Segis to supply farmers in the vicinity of those towns.

St. Joseph, Mo.—The Western Tablet Co. will build a one-story power plant at its factory, 11th and Mitchell streets. The plant will be 40 by 100 ft., and is estimated to cost about $35,000.

St. Louis, Mo.—The Lignite Products Co., 1100 Title Guaranty building, is planning the development of extensive lignite properties in Texas and Louisiana, to be operated in connection with a by-product plant for the manufacture of fuel briquettes. Equipment for initial operation will be secured at an early date, including electrical generating machinery, motors and other apparatus. Walter Powell is the president of the company.

St. Louis, Mo.—A valuation of $47,035,000 has been placed on the properties of the United Railways Co., according to information given out by the Missouri Public Service Commission. The valuation was made in connection with a fare increase sought by the company.

St. Louis, Mo.—Swift & Co., Chicago, have completed plans for a one-story addition to its power plant at St. Louis, to cost about $100,000.

York, Neb.—The city lighting system will be changed from a five-lamp cluster to a one-lamp system. A. E. Mead is the city engineer of York.

SOUTH CENTRAL STATES

Litchfield, Ky.—The Grayson County Telephone Co. has increased its capital stock from $5000 to $50,000.

Louisville, Ky.—The Automatic Switch Light Co., 304 West Breckenridge street, recently organized to manufacture automatic switches for electrical service and service and other specialties, is having preliminary plans prepared for its plant, and will call for bids about Sept. 1. J. W. Roberts is the president of the company.

Smithville, Tenn.—The city council has approved plans for the construction of a new transmission line to connect with the power plant of the Great Falls Power Co. at Rock Island. It is estimated to cost about $30,000.

Attalla, Ala.—The Alabame Power Co. is rebuilding its local plant and will install additional equipment.

Springdale, Ark.—Goss & Early, Fayetteville, Ark., have purchased the local electric light and power plant and will remodel and improve it.

Monroeville, Ala.—The city will construct an electric light and power plant. Address mayor of Monroeville for further information.

Prattville, Ala.—J. L. Taylor, engineer, has prepared plans for the rebuilding of the hydroelectric plant of the Autraga Cotton Mills, recently destroyed by fire. The new plant will develop 300 hp. and is estimated to cost $32,000.

Cleveland, Miss.—The Home Light & Ice Co. has filed notice of increase in its capital stock from $10,000 to $40,000 for extensions in its electric lighting plant.

Little Rock, Ark.—The Little Rock Railway & Electric Co. will expend $313,000 in plant improvements.

Little Rock, Ark.—The Little Rock Railway & Electric Co. is planning for extensions in its electric power plant, including a new turbogenerator, boilers, condensers and other auxiliary equipment. The company has arranged for a bond issue of $263,000 for this work and other expansion.

Pine Bluff, Ark.—The Arkansas Light & Power Co. has completed construction on a 33,000-volt transmission line from England to Stuttgart, enabling the company to supply electrical energy to 130 rice irrigation pumps and a number of towns and farms north of Pine Bluff.

Muskogee, Okla.—The Southwestern Bell Telephone Co. plans to install underground conduit for telephone cable, at an estimated cost of $700,000.

Amarillo, Tex.—The Amarillo Power and Light Co. plant was recently destroyed by fire with a loss of $100,000.

Brownwood, Tex.—McCully & Co. is in the market for power equipment.

Gainesville, Tex.—The Gainesville Telephone Co. plans improvements to its system, at an estimated cost of $70,000.

WESTERN STATES

Brigham City, Utah.—The city plans to rebuild and add new equipment to the city electric light plant. Address C. O. Roskelly, city manager, for further information.

Anaconda, Mont.—Construction of a power line from Butte to the Boston & Montana Development Co's. mine in the Elkhorn district will be undertaken by the company according to John D. Pope, general manager. The mine plant requires about 1500 hp. Material for the power line is now at the property.

Butte, Mont.—The Montana Power Co. this season has built 150 mi. of 50,000-volt transmission line from Harlowton, via Roundup, to Billings, thus completing a circuit of Great Falls, Helena, Butte, Bozeman, Billings, Roundup and Harlowton.

Helena, Mont.—The Commercial Club has taken up with the city authorities the proposal to establish a new lighting system the full length of Helena avenue.

Melville, Mont.—The Livestock Telephone Co. has been incorporated with capital stock of $3600. W. H. Donald and others are the incorporators.

Missoula, Mont.—A corporation is being formed to establish a hydroelectric plant at the mouth of Rock creek, to develop about 20,000 hp. The greater part of power so developed will be used for pumping water for delivery in the Desmet irrigation district.

Rock Creek, Mont.—The state commissioners plan to erect power plant with a capacity of 20,000 kw. at Rock Creek.

Bonners Ferry, Ida.—Directors of the Kootenai Valley Commercial Club are discussing the matter of proceeding with a bond election to finance the construction of a municipal lighting plant.

Bonners Ferry, Ida.—C. D. Aspinwall, of the Westinghouse Electric & Manufacturing Co., has made a report on a proposed power site and plant on the Moyie river and an estimate of the cost of equipment. The proposed plant will require a 500-hp. hydroelectric unit, to operate under a head of 70 ft., and a steel penstock 200 ft. long.

Bellingham, Wash. — Application has been made by the Puget Sound Power & Light Co. for a 50-year franchise to extend its power lines over roads in Whatcom county and to many parts of the county not now supplied with light and power.

Yakima, Wash.—The Pacific Power & Light Co. has plans for the construction of a boiler house, to cost $10,000.

Klink, Cal.—The substation operated by the Southern California Edison Co. here was recently destroyed by fire.

INCORPORATIONS.

Butler, Okla.—The Butler Telephone Co. has been incorporated with capital stock of $5000. William Walker is the principal incorporator.

Dallas, Tex.—The Dallas Power & Light Co. has arranged for a bond issue of $700,000 for extensions and improvements. The company will build an addition to its local power plant to cost about $100,000.

Holland, Tex.—The Farmers Electric Gin Co. has been incorporated with capital stock of $15,000. C. B. Starke, J. P. Edwards and W. A. McKee are the incorporators.

Benton Harbor, Mich.—The Saranac-Automatic Machine Corp. has been incorporated with capital stock of $400,000 for the manufacture of special machinery. Edward Craig is the president of the company.

Boston, Mass.—The Nokol Oil Burning Devices, Inc., has been incorporated with capital stock of $75,000 to manufacture heating devices. Leslie B. Sanders, Newton, Mass., Peter Giunts and Ralph E. Joslin, Winchester, Mass., are the incorporators.

Toronto, Ont.—The Instantaneous Electric Heater, Ltd., has been incorporated with capital stock of $250,000 to manufacture electrical goods, heaters, stoves, etc. James E. Day, Joseph P. Walsh, Frederick R. Marshall and others are the incorporators.

Sea Cliff, N. Y.—H. S. Fitzgibbon & Co., Inc., has been incorporated with capital stock of $300,000, to manufacture power-plant specialties. R. N. Phinney, R. W. Crawford and H. Schubert, 120 Broadway, New York City, are the incorporators.

Pittsburgh, Pa. — The Concordia Electric Co. has been incorporated with capital stock of $200,000 to manufacture safety lamps for miners. Emil Winter, Dwight Winter and others are the incorporators.

Petrolia, Ont.—The Orton Motor Co., Ltd., has been incorporated to manufacture motors, engines, machinery, tools, etc., with capital stock of $500,000. Alfred Orton, Detroit, Frank A. Halstead, Port Huron, Mich., and John Frazier, Petrolia, are the incorporators.

Montreal, Que.—D. J. Loomis & Sons, Ltd., has been incorporated to carry on a business of engineering and contracting with capital stock of $1,300,000. John P. Wells, Charles D. White and others are the incorporators.

New York, N. Y.—The Maxwell Electric Specialties Co. has been incorporated with capital stock of $20,000. M. J., L. and S. Gallubier, 855 Whitlock avenue, are the incorporators.

New York, N. Y.—The Reed Wire Specialties Corp. has been incorporated with capital stock of $500,000. C. A. Davidson, Mamoroneck, N. Y., and others are the incorporators.

Wheeling, W. Va.—The White Sulphur Motor Co. has been incorporated with $25,000 capital stock to manufacture electrically driven motors. J. C. Myers, E. Z. Ramsey, B. M. Ayers, W. E. Williams and John Kessinger are the incorporators.

PROPOSALS

Sealed proposals will be opened at the office of the Supervising Architect of the Treasury Department, Washington, D. C., on Aug. 24, for the installation of an electrically operated dumb waiter shaft and hoistway in the United States postoffice at Fitchburg, Mass. Copies of the drawings and specifications can be obtained from the office of the supervising architect or from the custodian of the post office, Fitchburg, Mass.

FOREIGN TRADE.

[Addresses of firms referred to in these trade opportunities may be obtained by writing to the Bureau of Foreign and Domestic Commerce, Washington, D. C., or its branch and local co-operative offices. Request for each opportunity should be on a separate sheet and the file number given.]

Lamp Sockets, etc. (33,194)—An electrical goods firm in Canada desires to purchase automobile accessories and small varieties of electrical goods, such as lamp sockets, adapters, and connectors. Quotations should be given f. o. b. shipping point. Payment will be made by on sight draft.

Electrical Supplies (33,198)—A manufacturer's agent in Australia desires to secure an agency for the sale of all kinds of supplies and wire for electric household and office appliances, also mica and general electric supply lines.

FINANCIAL NEWS

Comment on the Financial Outlook in the Electrical Industry, New Securities, Reports of Earnings, Dividends and Utility Stocks

Montana Power Co. Reports Heavy Increase in Earnings.

The Montana Power Co. for the six months ended June 30 reported net earnings after taxes and fixed charges of $1,879,342, against $1,422,716 for the corresponding period of last year. The figures furnish a good basis for estimating what the company can be expected to show this year. It is believed that earnings available for the common stock will approximate close to $7 a share on the 466,333 junior shares outstanding and entitled to dividends against $3.43 a share earned last year.

The net earnings after fixed charges and allowances for preferred dividend requirements for the six months just reported are equal to $3.30 a share on the common stock. However, this does not include a depreciation charge which is not computed until the end of the year. Last year this item was carried at $300,000, and if a similar charge-off is made at the end of this year, earnings on the common for the first half were $2.98 a share, or at an annual rate of $5.96. Further improvement in earnings is looked for, though it is pointed out that during the summer months earnings are somewhat smaller due to a lessening demand for gas and electricity from domestic users.

General conditions in Montana have improved considerably this year. In 1919 at this time the state was suffering from a severe drought which was reflected in poor earnings. There is now abundance of water for hydroelectric and crop use. The activity of the zinc and silver mining industries throughout the state has helped earnings to some extent as they are large users of power. The completion of the extension of lines to the coal mines at Roundup and Carpenters Creek is expected soon and electrical energy will then be delivered to this industry.

Cumberland County Power & Light Co.

	1920.	1919.
May gross	$ 239,753	$ 201,289
Net after taxes	72,170	46,881
Surplus after charges	16,202	2,784
Twelve months gross	2,926,660	3,060,868
Net after taxes	998,579	931,102
Surplus after charges	329,322	147,358
Balance after preferred dividends	191,322	9,358

Nevada-California Electric Corp.

	1920.	1919.
May gross	$ 250,658	$ 214,442
Net after taxes	129,647	129,525
Total income	128,453	129,328
Surplus after charges	56,543	58,077
Five months gross	1,142,420	915,440
Net after taxes	579,199	529,147
Total income	575,880	527,422
Surplus after charges	219,617	186,588

Adirondack Electric Power Co.

	1920.	1919.
June gross	$ 177,464	$ 123,891
Net after taxes	53,242	53,262
Surplus after charges	25,203	26,360
Twelve months' gross	1,984,725	1,787,550
Net after taxes	711,220	498,464
Surplus after charges	384,709	230,250

Blackstone Valley Gas & Electric Co.

	1920.	1919.
May gross	$ 248,099	$ 195,864
Net earnings	69,341	51,987
Surplus after charges	44,481	27,674
Twelve months gross.	2,949,172	2,530,148
Net earnings	896,882	662,388
Surplus after charges	598,137	373,150

Reading Transit & Light System.

	1920.	1919.
May gross	$ 271,551	$ 223,572
Net after taxes	21,433	41,367

Plan Merger of Eight Companies in Eastern Pennsylvania.

To effect a merger of eight public utilities in the Allentown, Pa., district, recently approved by the State Public Service Commission, the Pennsylvania Power & Light Co. has arranged for a stock issue of $9,791,132, the proceeds to be used in part for proposed plant extensions and line betterments. The companies, to operate under the name noted, include the Lehigh Valley Light & Power Co., Northern Central Gas Co., Columbia & Montour Electric Co., Northumberland County Gas & Electric Co., Harwood Electric Co., Schuylkill Gas & Electric Co., and Pennsylvania Lighting Co. The operation will be conducted in the future as one property, with various power stations connected by high-voltage transmission lines. Additional facilities as now being planned are to provide for the heavy increasing demands for power from the different industries in this section. The new company will be under the jurisdiction of the Electric Bond & Share Co., 71 Broadway, New York City.

Southern California Edison Co.

	1920.	1919.
June gross	$1,185,662	$ 846,794
Net earnings	591,964	469,028
Total income	720,561	596,824
Surplus after interest charges	462,078	338,752
Six months' gross	5,356,293	4,273,986
Net earnings	2,742,515	2,494,055
Total income	3,481,221	3,094,178
Surplus after interest charges	1,966,356	1,514,098

Tennessee Railway, Light & Power Co.

	1920.	1919.
May gross	$ 548,713	$ 421,082
Net after taxes	200,805	131,352
Surplus after charges	72,172	1,407
Twelve months' gross	5,889,716	5,689,756
Net after taxes	2,132,210	2,241,500
Surplus after charges	583,706	712,423

Havana Electric Railway, Light & Power Co.

	1920.	1919.
May gross	$ 946,301	$ 740,304
Net earnings	483,993	387,628
Total income	495,463	407,062
Surplus after fixed charges	366,866	215,568
Five months' gross	4,587,376	3,576,815
Net earnings	2,329,914	1,800,638
Total income	2,359,044	1,853,015
Surplus after fixed charges	1,412,407	761,869

Mississippi River Power Co.

	1920.	1919.
May gross	$ 238,349	$ 198,593
Net earnings	185,862	151,421
Surplus after charges	86,613	48,135
Twelve months gross.	2,452,639	2,222,690
Net earnings	1,916,587	1,741,160
Surplus after charges	788,560	497,689

New England Co. Power System.

	1920.	1919.
May gross	$ 472,459	$ 293,156
Net after taxes	150,108	140,799
Surplus after charges	83,204	75,853
Twelve months gross.	4,973,703	3,800,686
Net after taxes	1,517,783	1,443,124
Surplus after charges	750,434	709,448

Dividends.

The J. G. White Engineering Corp., New York City, has declared its annual dividend of 1½% on its common stock, payable Sept. 1 to stockholders of record Aug. 16. The company has also declared an extra dividend of 6% payable at the same time.

The Brooklyn Edison Co. has declared its regular quarterly dividend of $2 a share, payable Sept. 1 to stockholders of record Aug. 20.

The American Water Works & Electric Co. has declared its regular quarterly dividend of 1¾% on its 7% cumulative preferred stock, payable Aug. 16 to stockholders of record July 31.

WEEKLY COMPARISONS OF CLOSING-BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeiler Co., Rookery Bldg., Chicago.

	Div. rate. Per cent.	Bid July 27.	Bid Aug. 3.
Public Utilities—			
Adirondack Electric Power of Glens Falls, common	6	10	13
Adirondack Electric Power of Glens Falls, preferred	6	70	72
American Gas & Electric of New York, common	10+extra	100	97
American Gas & Electric of New York, preferred	6	36	34
American Light & Traction of New York, common	..	121	116
American Light & Traction of New York, preferred	6	81	81
American Power & Light of New York, common	4	47	44
American Power & Light of New York, preferred	6	65	65
American Public Utilities of Grand Rapids, common	..	4	4
American Public Utilities of Grand Rapids, preferred	7	16	15
American Telephone & Telegraph of New York	..	91	90
American Water Works & Elec. of New York, common	..	2	2
American Water Works & Elec. of New York, particip	7	6	5
American Water Works & Elec. of New York, first preferred	..	36	35
Appalachian Power, common	..	6	4
Appalachian Power, preferred	7	18	17
Cities Service of New York, common	+extra	316	300
Cities Service of New York, preferred	6	66	65
Commonwealth Edison of Chicago	8	102	100
Comm. Power, Railway & Light of Jackson, common	..	18	17
Comm. Power, Railway & Light of Jackson, preferred	6	38	37
Federal Light & Traction of New York, common	..	7	6
Federal Light & Traction of New York, preferred	..	43	43
Northern States Power of Chicago, common	..	28	27
Northern States Power of Chicago, preferred	ex.div.7	76	75
Pacific Gas & Electric of San Francisco, common	..	46	46
Public Service of Northern Illinois, Chicago, common	7	67	65
Public Service of Northern Illinois, Chicago, preferred	6	74	74
Standard Gas & Electric of Chicago, common	..	13	13
Standard Gas & Electric of Chicago, preferred	6	35	35
Tennessee Railway, Light & Power of Chattanooga, common	..	½	1
Tennessee Railway, Light & Power of Chattanooga, preferred	6	2	2
United Light & Railways of Grand Rapids, common	4	19	18
United Light & Railways of Grand Rapids, preferred	6	58	56
Western Power of San Francisco, common	..	15	21
Western Union Telegraph of New York	extra	82	80
Industrials—			
Electric Storage Battery of Philadelphia, common	4	100	98
General Electric of Schenectady	8	146	146
Westinghouse Electric & Mfg. of Pittsburgh, common	7	52	52